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JAINA BIOLOGY

EDITORS

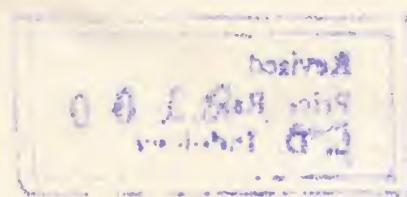
R. S. BETAI

Y. S. SHASTRI

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Edsitorial

We are glad to place the present work before scholars and interested readers. Jainism and Jaina writers are renowned for their unique writings in the realm of philosophy, poetry, grammar, Ācāradharma, and a host of other subjects in which their contribution to knowledge is very great. The present work shows that their study of sciences is also unique in its own way.

The 'Preface' by the scholar - researcher - writer speaks for the value of the work. We do not therefore repeat it here.

It is sincerely hoped that the work will be welcomed by all interested.

—Editors

Dedicated
To
Shrimati Parulk. Nawab.

JAINA BIOLOGY

Preface

Jaina Biology is a unified body of facts and theories, concerned with all the myriad facets of all kinds of living beings, and it is not simply a mixture of Botany and Zoology, Anatomy and Physiology, heredity and evolution, or any other of the life sciences, for, the Jainācāryas studied the world of life from the religious and philosophical points of view on the basis of the concept of spiritual value of life.

To bring to the fore the biological principles which underlie the study of living things in 'Jaina Biology', some of the major generalizations of Jaina Biology are briefly discussed in the Introduction of the work. These, of course, cannot be fully appreciated at the first reading but they should be helpful in proving a frame of reference for the succeeding chapters.

The Introduction, the first chapter and the first section of the second chapter of 'Jaina Biology'-emphasize similarity of life-processes of all organisms, for many of the advances in Biology have been demonstrated first in experiments with micro-organisms as it is found in Jaina Biology that the study of life began with the concept of Nigodas (Micro-organisms).

Jaina Biology contains partial discussions of cell-structure, cell-metabolism, photosynthesis and genetics to some extent.

In writing a text of Jaina Biology it is difficult to steer a true course between the scylla of superficiality and the charybdis of over detail. This work attempts to present some facts and principles of Biology without superficiality, yet without undue emphasis on detail. It emphasizes the basic unity of life and the fundamental similarities of the problems, faced and solved by all living substances.

After the introductory part describing the biological sciences of scientific information on Jaina Biology, the scientific method and some generalizations, inter-relations of organism and environment, the first chapter describes and explains the fabric,

systems, particularly men, obtain biologically useful energy. The second chapter presents a discussion on the world-life: plants, biologic inter-relationship, the classification of living substances made of nutrition of plants and animals, habitat and ecologic niche, types of interactions between species of plants and animals, together with the general properties of green plant cell-respiration of plants, the skeletal system of plants, plant digestion, plant circulation, plant sap, plant excretion, plant co-ordination, transmission of impulses of plants and their sleep movement. The remainder of the second chapter describes the structures and functions of a seed plant—the functions of roots, stems and leaves, transpiration, the movement of water and the storage of food. It surveys the plant kingdom—types of plants: trees (vṛkṣas), shrubby plants (gucchas), shrubs (gulmas), creeping plants (vallī), knotty plants (parvaga), grasses (trṇas), palms (valayas), herbs (haritas), cereals or annual plants (osahi), water plants (jalaruha), mushrooms (kuhana), gross plants having common body (sādhāraṇāśarīrabādaravanaspatikāyikas), subtile plants (sūkṣma vānaspati), bacteria, micro-organism (nigodas), algae (sevāla) and fungi (panaga), the evolution of plant reproduction, germination of the seed and its embryonic development and the evolutionary trends in the plant kingdom.

A similar survey of the invertebrate (two-sensed to four-sensed animals), and vertebrate animals (five-sensed animals) and their structural and functional peculiarities is provided in the third chapter. It deals with a classification of animals based upon observation of similarities of structure, sense-organs, made of origin and development and includes in it lower invertebrates—the phylum protozoa (the subtile undeveloped two-sensed animals), the life of two-sensed animals, the higher invertebrates (some of the two-sensed animals, three-sensed and four sensed animals), the phylum chordata (five-sensed animals)—the vertebrates, classes of the sub-phylum vertebrata—fish (matsya), amphibia (frog manḍūka), reptilia (parisarpas)—lizard, etc., aves (pakṣi)—birds and mammalia (all mammals up to man).

The organ system of the vertebrate human body are described in some details in the fourth chapter. The organization of the human body consists of the transport system of it, i.e. blood and blood vessels, and the circulatory system, the respiratory system, the digestive system, the excretory systems, the integumentary and skeletal systems, the muscular systems, the sense-organs and the endocrine system.

The features of the human reproductive process and of embryonic development are presented in the fifth chapter and some principles

of human are dealt with in the sixth chapter. Certain aspects of inheritance in man and a side-light on the development of genetics are discussed there.

The evolutionary and ecologic relationship of living organisms are treated in the seventh chapter. The principles of evolution, the evidence underlying it, the principles of ecology and the outcome of evolution: adaptation are explained in this chapter.

The concluding chapter contains a survey of plant and animal kingdoms as described in Jaina literature in the light of modern Biology. It should serve as a convenient reference and aid the readers in recognizing place in the plant and animal kingdoms of the organisms and the importance of the Jaina study of the world of life in the history of the biological sciences in India.

In this connection, I am greatly indebted to Late Prof. G. A. Kapadia, the ex-Head of the Department of Botany, St. Zaviers College, Ahmedabad, and Dr. Avinash Vohra, Professor of Botany, Gujarat University, who encouraged me to carry on the research work on Jaina Biology and helped me in all possible ways for treating the subject in the light of modern Biology with their knowledge and experience in the field of Biology. My special thanks are given to Sri Dalsukhbhai D. Malvana, the ex-Director of L. D. Institute, Pandit Rupendra Kumar Pagarja and Pandit Babubhai Savchand Shah for their valuable suggestions and references to biological data in the Jaina Āgamas and Post-āgamic texts in working out this thesis 'Jaina Biology'. I am thankful to Dr. Y. S. Shastri Acting Director, L.D. Institute of Indology Ahmedabad taking up this work for publication with great earnestness.

15th December, 1974.

J. E. SIKDAR
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Ahmedabad-380 009

ERRATA

Page	Line	Incorrect	Correct
2	8	greately	greatly
4	10	graduals	graduals
12	15	more	mere
15	25	know	known
48	4	baecteria	bacteria
	14	luminicent	luminiscent
55	5	started	stated
57	27	mutrition	nutrition
70	12	twings	twigs
73	11	lomāha in	lamahārin
110	23	same	some
150	20	heme	hemo
153	6	the	ten
166	11	take	takes
167	24	specilized	specialized
182	25	(U)pastha	Upastha
194	4	gridle	girdle
209	29	rest	taste
213	15	starting	stating
215	Footnotes in text 24 to 28 to be read as 78 to 82		
297	14	circulatary	circulatory

JAINA BIOLOGY

INTRODUCTION

1. Jaina Biology and the Scientific Method

Biology is the science of living substance (Jivadravya)¹ which is different from non-living substance (ajivadravya)². It is a very old science of living substances for solving the fascinating riddle of life. The survival of early men required a knowledge of such basic facts as which plants and which animals could be safely taken as food and medicine. In the Jaina Āgamic literature the word 'Jivatthikāya'³ is used to refer to any living substance, plant or animal, from nigoda⁴ (micro-organism) up to the pañcendriya manusya⁵ (five-sensed human beings), just as the word 'organism'⁶ in modern age is used to denote any living thing, plant or animal, from amoeba to man.

The study of Biology began with the Jainas on the basis of the doctrine of animism⁷ and ahimsā⁸ (non-violence) in the hoary past, besides the requirement of food to sustain life with a sense of spiritual value of life of all beings. They kept in view the concepts of living substance as contained in the Vedic⁹ and post-Vedic¹⁰ literature, describing the external and internal parts of plants and animals with their nomenclature, classifications, etc.

1. Bhagavatī Sūtra, śataka 25, uddeśaka 2, sūtra 720; Sthānāṅga Sūtra, 2, 95. p. 86; Pañṇavaṇā Sutta 1.3, P. 4.
2. Bhagavatī Sūtra, 25. 2. 720.; Pañṇavaṇā Sutta, 1. 3. p. 4.; Jivābhigama Sutta, P. 5.
3. Bhagavatī Sūtra 20, 2. 665.
4. Ibid., 25. 5, 749.
5. Ibid., 33. 1. 844.
6. Biology, C. A. Viliee, p. 16.
7. "Se bemi saṁtime tasā pāṇa, tamjahā-aṁdayā poyayā jnāraua rasaā saṁseyayā/ saṁmucchimā ubbhiyayā esa saṁsāretti pavuccai" Acārāṅga Sūtra, adhyayana 1, uddeśaka 6, sūtra 48, etc.
"Se hu muṇi poriṇṇāyakamme" (54).. Ibid; See SBE Vol. XXII, Pt. I, p, 11, Book 1. Lecture 1. 6th lesson; Sūtrakṛtāṅga 1, Adhyayana 7.
Puḍhavi ya āu agaṇi ya vāū, taṇa rukkha biya ya tasā pāṇā/Je aṁdyayā je ya jarāupāṇa, saṁseyayā je rasayābhīhāṇa (1)" etc....up to
"Nidhūya kammaṁ na pavaṁcuvei, akkhakkhae vā sagaḍam ti bemi "-30.
See SBE XLV, Pt. II, pp. 293, 302, Sūtrakṛtāṅga, Book 1, Lecture 7.
8. Bhagavatī Sūtra, 2. 1. 92, 95; 8. 5. 328; 11. 9. 417; 11. 22. 435.
9. See the Indian Journal of History of Science, Vol. 5, No. 1, 1970, Biology in Ancient and Medieval India, Dr. R. N. Kapil, pp. 125-132.
10. Ibid.
- J. B.-1

Biology as an organized science can be said to have begun with the Greeks¹¹ in the West on the basis of the knowledge of such basic facts as which plants and which animals were useful as food and medicine. "They and the Romans described the many kinds of plants and animals known at the time."¹²

Galen (131-200 A. D.),¹³ the first experimental physiologist, made experiments to study the functions of nerves and blood vessels. Biology expanded and underwent alteration greatly in the nineteenth century, and it has continued this trend at an accelerated pace in the twentieth century due to the discoveries and techniques of physics and chemistry.

Sources of Scientific Information on Jaina Biology :

The ultimate source of each fact of Jaina Biology contained in the Jaina Āgamic and post-Āgamic works is in some carefully controlled observation made by the Jainācāryas. They have made a discovery in the world of life, plants and animals, by their critical observation on them; they have described their methods in details so that their followers can repeat them, have given the result of their observations, discussed the conclusions to be drawn from them, perhaps formulated a theory to explain them, and indicated the place of these biological facts in the present body of scientific knowledge contained in the Jaina Āgamas.

The Scientific Method :

The facts of Jaina Biology as embodied in the Jaina canons are gained by the application of the scientific method, yet it is difficult to reduce this method to a simple set of rules of modern Biology that can be applied to the Jaina biological science, because the sceptical scientists of modern age want confirmation of the statement by the independent observation of another in any scientific investigation.

"The basis of the scientific method and the ultimate source of all facts of science is careful, close observation and experiment, free of bias, with suitable controls and done as quantitatively as possible."¹⁴ The observations made by the Jainācāryas on the world of life, plants and animals, may be analyzed, or simplified into their constituent parts in the light of modern Biology, so that some sort of order can be brought into the observed phenomena. Then the parts can be synthesized or reassembled and their interaction and interrelations

11. Biology, p. 1.

12. Ibid.

13. Ibid., p. 3

14. Ibid., p. 3.

discovered on the scientific basis. A method has been followed by the Jainas to see through a mass of biological data and they suggest a reason for their interrelations, as science advances only by scientific investigations: hypothesis, observation, revised hypothesis, further observation and so on. In the words of Einstein "In the whole history of science from Greek philosophy to modern physics, there has been constant attempts to reduce the apparent complexity of natural phenomena to some simple, fundamental ideas and relations."¹⁵

Some of the practical uses of a knowledge of Jaina Biology will become apparent in the fields of medicine and public health, in agriculture and conservation, its basic importance to the social studies, and its contribution to the formulation of a philosophy of life, together with aesthetic values, as it is impossible to describe the forms of life without reference to their habitats, the places in which they live, in a given region, being closely interrelated with each other and with the environment in the closely interwoven tapestry of life.

2. Some Generalizations of Jaina Biological Science

The idea that living systems are distinguished from non-living ones by some mysterious vital force (paryāpti)¹⁶ has gained acceptance in Jaina Biology, while one of the basic tenets of modern Biology is that "the phenomena of life can be explained in terms of chemistry and physics."¹⁷ The idea that the living systems are not distinguished from non-living ones by some mysterious vital force has only recently gained ground in Biology, only 40 years ago, when the German embryologist, Hans Driesch, postulated the theory of "the existence of transcendent regulative principles, entelechies, which control the phenomena of life and development."¹⁸

There appear to be no exceptions to the generalization that all life comes only from living things. Like the experiments of Pasteur, Tyndal and others,¹⁹ just century ago finally, the Jainācāryas, provided convincing proof that micro-organism, such as, nigodas, earth quadrates, etc., i. e. bacteria, are also incapable of originating from non-living material by spontaneous generation. It seems clear that nigodas require

15. *Ibid*, p. 4.

16. Parāpti (Vital force), Navatattva prakaraṇam, V, 6, p. 12; Lokaprakāśa, Vinayavijayaji, Pt. I, 3rd Sarga, vv. 15, ff.

17. Biology, p. 9.

18. Biology, p 9.

19. *Ibid.* *idem*, *di* *ci* *recole* *adi* (CS. T. 1. 1. 1945) *trivagadhi* *adi* *ci* *gulbrosa* A
trivagis *trivagis* *adi* *gulbrosa* *scutell* *to* *adi* *zhia* *adi* *to* *alliedanus* *na* *will* *emarginata*
(*alliedanus*) *ogham* *baohassamum* *g* *adi* *ci* *bi*

the presence of pre-existing nigodas,²⁰ just as the virus of modern Biology does so. Nigodas (micro-organisms) do not arise *de novo* from non-nigodas, just as viruses do not do so from non-viral material.²¹

Elements of the idea that all of the many kinds of plants and animals existing at the present time were not created *de novo* and were eternally existing and have descended from previously existing organisms are clearly expressed in the *jaina* texts,²² but they have their gradations.²³ The theory of organic evolution that all of the many kinds of plants and animals "have descended from previously existing simpler organisms by graduals modifications which have accumulated in successive generations has gained ground among the modern Biologists as one of the great unifying concepts of Biology. Elements of this were implicit in the writings of certain Greek philosophers before the Christian era, from Thales to Aristotle."²⁴

The *Jaina* studies of the development of many kinds of animals and plants from fertilized egg²⁵ or embryo²⁶ to adult leads to the generalization that organisms tend to repeat in the course of their embryonic development, some of the corresponding stages of their evolutionary ancestors. According to this theory of recapitulation, embryos recapitulate some of the embryonic forms of their ancestors,²⁷ while modern Biology goes a step forward and states that "the human being, at successive stages in development resembles in certain respects a fish embryo, then an amphibian embryo, then a reptilian embryo and so on."²⁸

20. *Bhagavati Sūtra*, 25. 5. 749.

Nigodas are of two kinds, viz. *Nigodakā* and *Nigodajīva* (fine and gross nigodas). They are the collections of infinite number of beings, making minute group, having common breathing-in and out (respiration), sense-feeling. They, longing for development, continue evolution of life through the successive *Jivaparyāyas* (modes of beings of soul) and they provide the supply of beings in the place of those who have attained liberation. Thus the universe does not become and will not become empty of living beings (*Bhagavatī*, 12. 2. 443).

21. *Biology*, p. 9.

22. *Bhagavati Sūtra*, 12. 2. 443; *Tattvārtha Sūtra*, 5. 3. (*Nityāvasthitānyarūpāṇi ca*)

23. *Bhagavati Sūtra*, 12. 2. 443.

24. *Biology*, p. 10.

See *A History of Greek Philosophy*, Vol. I, II and III, by W. K. C. Guthrie; Aristotle by Ross.

25. *Bhagavati Sūtra*, 7. 5. 282.

26. *Bhagavati Sūtra*, 7. 7. 283.

27. *Ibid.* 1. 7. 61.; *Tandulaleyālya*, 6. p. 10.

28. *Biology*, p. 11.

According to the *Bhagavati Sūtra* (1. 7. 62), the foetus in the mother's womb remains like an umbrella or the side ribs of human body; the embryo appears to be like a humpbacked mango (*ambakhujjae*).

Inter-relations of Organism and Environment :

A careful study of communities of plants and animals in a given area as described in the Jaina Āgamas leads to the generalization that all living beings in a given region are closely interrelated with one another and with the environment.

It includes the idea that particular kinds of plants and animals are not found at random over the earth but occur in interdependent communities of producer, consumer and decomposer-organisms together with certain non-living components. These communities can be recognized and characterized by certain dominant members of the group, usually plants, which provide both food²⁹ and shelter for many other forms. This eco-system is one of the major unifying generalizations of Biology. These few biological principles given here are intended to emphasize the fundamental unity of Jaina biological science and the many ways in which living substances are interrelated and interdependent.

Like all ancient people, the Jainas lived in close association with nature and made a scientific study of the world of life, plants and animals, by careful observations on their lives, activities and properties, etc., over a long period of time. The result of their discoveries as embodied in the Āgamas is conducive to further studies of the problems and mysteries of the world of life on the basis of new information and further revisions of some of these principles.

29. *Bhagavati Sūtra*, 6. 7. 246; 6. 5. 330; 7. 3. 277; 8. 3. 324; 8. 5. 330; 21. 2. 691.
 22. 6. 692; 23. 1. 993; etc.; *Sūtrakṛtāṅga* II. 3.

FIRST CHAPTER

CELL STRUCTURES AND FUNCTIONS

(First Section)

1. The Fabric of Life

As defined, Biology is the science of living substances (jivadravayas). The field of Jaina Biology differentiates the living from the non-living by using the word 'Jivatthikāya'¹ (organism) to refer to any living things, plant or animal, just as modern Biology does. So it is relatively easy to see that a man,² a Sāla tree,³ a creeper⁴ and an earthworm⁵ are living, whereas pieces of matter (pudgala),⁶ e.g. earth, stones, etc., are not so. But according to modern Biology, "it is more difficult to decide whether such things as viruses are alive."⁷

Jaina Biology, states that the fabric of life of all plants and animals is paryāpti⁸ (Śakti=Vital force) or Prāna⁹ (life force) in another way, i.e. paryāpti appears to be the actual living material of all plants and animals. There are stated to be six kinds of paryāpti¹⁰, viz. āhāraparyāpti (vital force by which beings take, digest, absorb and transform molecules of food particles into khala (waste products) and rasa (chyle=molecules of nutrients or energy)¹¹, śariraparyāpti (vital force) by which chyle or molecules of nutrients (=rasibhūtamāhāram) are utilized by beings for the release of energy, the building of blood,

1. Bhagavatī Sūtra, 20. 2. 665.
2. Bhagavatī Sūtra, 33. 1. 844; Uttarādhyayana Sūtra, 155; Tattvārtha Sūtra, II. 24.
3. Bhagavatī Sūtra, 22. 1. 692.
4. Ibid., 23. 4. 693.
5. Tattvārtha Sūtra, II. 24.
6. Bhagavatī Sūtra, 2. 10. 118.
7. Biology, p. 16, Ville, c. 4.
8. Pajjatti = Paryāpti, Navatattva Prakaraṇa, v. 6; Dharmavijay, p. 12.; Gommaṭasāra Jivakāṇḍa, vv. 118-119; Lokaprakāśa, Vinayavijaya, Pt. I, 3rd Sarga, vv. 15 ff.
9. Jivavicāra, vv. 42, 43; Gommaṭasāra, Jivakāṇḍa, v. 129.
10. Navatattvaprakaraṇa, v. 6.
Āhāra-sarira-imdiya, pajjatti āṇapāṇa bhās-amaṇe /
Cau-pāṇca-chappiya, iga-vigala asaṇṇi-sanninam // 6,
Navatattva Prakaraṇam, Dharmavijaya and also see Lokaprakāśa, Vinayavijaya, Pt. 1, 3rd Sarga, vv. 15 ff; Gommaṭasāra, Jivakāṇḍa, 119.
11. Tatraisāhāraparyāptiryayādīya nijocitaṁ nayet /
Pṛthakkhalarasatvenāhāraṁ paripatīm nayet // Lokaprakāśa, I. 3. 17.

tissue, fat, bone, marrow, semen, etc.,¹² inbriyaparyāpti¹³ (vital force by which molecules of nutrients or chyles suitable for building senses are taken in and provided to the proper place so that beings can have the perceptual knowledge of the desired sense-objects by the sense-organs)¹⁴ acchvāsaparyāpti¹⁵ (Vital force by which particles of respiration are taken in, oxidized for energy and left out (as carbon dioxide and water), bhāsāparyāpti¹⁶ (vital force by which beings, having taken proper particles of speech, emit them as speech) and manahparyāpti¹⁷ (vital force by which beings, having taken particles [or dusts] of mind, transform them by the mental process and give vent to them as the mental force, i. e. thought).

It appears that this paryāpti (vital force) is not a single substance but varies considerably from organism to organism (i.e. one-sensed to five-sensed being), among the various parts of a single animal or plant, and from one time to another¹⁸ within a single organ or part of an animal or plant. There are six paryāptis, but they share certain fundamental physical and chemical characteristics.¹⁹

12. Vaikriyāhārā.....yathocltam /
 tam rasibutamāhāram yayā śaktyā punarbhavi /
 Rasāśgmaṁsamedosthimajjaśukrādīdhātūtām /
 nayedyatāsambhayaṁ sā dehaparyāptirucyate // (19)
 Lokaprakāśa, p. 65; Pt. I, 3rd Sarga.

13. Dhātutvena pariṇatādāhāradīnidriyocitan /
 Ādāya pudgalāṁstāni yathāsthānaṁ pravidhāya // (20)
 Iṣṭe tadvīṣayajñaptau yayā śaktyā śarīravān
 paryāptih sēndriyāhvānā darśitā sarvadarśibhiḥ (21) Ibid., pp. 65, 66.

14. According to the Prajñāpanā sūtra (Indriyapada), Jivābhigama Sūtra, Pravacanasāroddhāra (Com.) etc., the power by which the molecules of nutrients or chyles which are utilized for building of sense-organs are called indriyaparyāpti, Vide, Ibid., p. 66.

15. Yaśocchvāsārhamādaya dalaṁ pariṇamarya ca /
 Tattayālambya muñcet so 'accvāsaparyāptirucyate // (22) Ibid., p. 66.

16. Bhāśārhamā dalaṁdāya gisṭvām nītvavalambya ca /
 yayā śaktya tyajet prāṇi bhāśāparyāptiritpāsau" // (29) Ibid., p. 67.

17. Dalaṁ lātvā manoyogyaṁ tattām nītvavalambya ca /
 yayā mananaśaktalā syānmanahparyāptiratra sā // (30) Ibid.

18. Pajjattipaṭṭhavaṇām jugavaṇā tu kamen hodi niṭṭhavaṇām / aṁtomuhuttakālenā-
 hiyakamā tātīyālāvā // Gommaṭasāra (Jivakānda), 120
 The gaining of the capacities starts simultaneously, but the completion (of each
 of them) is effected gradually within the period of one antarmūhūrta, which
 increases in the case of each succeeding one. Yet their total period does not
 exceed one antarmūhūrta.

19. Ibid., 121.

It is stated that there are ten kinds of *prāṇa*²⁰ (living material or life force), viz. five *indriyaprāṇas* (life force of five senses), *ucchvāsa-prāṇa* (life force of respiration), *āyuprāṇa* (life force of length of life), *manovāk-kāyaprāṇas* (life forces of mind, speech and body).

Actually speaking, these ten *prāṇas* are almost contained in six *paryāptis*, e. g. *indriyaparyāpti* contains five *indriyaprāṇas*, *ānaprāṇaparyāpti* = *ucchvasaprāṇa*, *śarīraparyāpti* = *kāyaprāṇa*, *bhāṣāparyāpti* = *Vākprāṇa*, *manāḥaparyāpti* = *manāḥaprāṇa*, only *āyuprāṇa* appears to be an addition.

Thus it is found that most of the *paryāptis* and the *prāṇas* have common names. So the question is whether there is any difference between them. The *Gommaṭasāra* explains the difference in this way that *paryāpti* is attainment of the capacity of developing body, mind, speech and five senses, while *prāṇa* is the activity of those functionaries.²¹

It is further explained that one-sensed beings possess four *prāṇas* or *balas* (life-forces), viz. sense of touch, respiration, length of life and body; two-sensed beings have six *prāṇas*, viz. senses of touch and taste, respiration, length of life, body and speech, three-sensed beings have seven *prāṇas*, viz. senses of touch, taste and smell, respiration, length of life, body and speech; four-sensed beings have eight *prāṇas* viz. senses of touch, taste, smell and sight, respiration length of life, body and speech. In *asāmjñī pañcendriya jivas* (five-sensed beings having no physical mind) but psychical mind there are nine *prāṇas* viz. senses of touch, taste, smell, sight and hearing, respiration, length of life, body and speech, while there are ten *prāṇas* in *śāmījñī pañcendriya Jīvas* (five-sensed beings having physical mind and psychical mind). viz. senses of touch, taste, smell, sight and hearing, respiration, length of life, body, speech and mind.²²

According to the *Cārvākas*, life (as well as consciousness) is a result of peculiar chemical combinations of non-living matter or the

20. *Dasahā jivuṇā pāṇā imdiusāsāujogabalarūvā/*
egimdiiesu cauro, vigalesu cha satta aṭheva // (42)
Asaṇṇi-saṇṇi-paṇclimciimdiiesu nava dasa kameṇa boddhavvā 43, Jivavicāra,
Paṇca vi imdiyapānā maṇavaeikāyesu tiāāi balapānā /

21. *Gommaṭasāra*, *Jivakāṇḍa*, p. 90.

22. *Jivavicāra*, vv. 42-43.

“ *Ekendriyeṣu-prthiviyādiṣu catvāraḥ prāṇāḥ sparśanendriyocchvāsāyuhkāyabalārūpaḥ dvindriyeṣu catvārasta eva vāgbalarasanendriyayataḥ ṣaṭ prāṇā bhavanti/ tathā trīndriyeṣu ṣaṭ prāṇāsta eva ghrāṇendriyānvitāḥ sapta bhavanti tathā caturindriyeṣu saptaiva cakṣurindriyasahitā aṣṭau prāṇā bhavanti/tathā asāmjñīpañcendriyeṣu aṣṭau ta eva śrotrendriyayatā nava prāṇā bhavanti/tathā śāmījñīpañcendriyeṣu ngyata eva manoyuktā dasa prāṇā bhavanti/”*

four elements, in organic forms just as the intoxicating property of spirituous liquor is the result of the fermentation of unintoxicating rice and molasses.²³ Similarly, the instinctive movements and expression of new born babies (sucking, joy, grief, fear, etc.) take place mechanically a result of external stimuli as much as the opening and closing of the lotus and other flowers at different times of the day or night²⁴, or the movement of iron under the influence of loadstone.²⁵ In the same way, the spontaneous reproduction of living organisms frequently occurs, e.g. animalcules develop "in moisture or infusions, especially under the influence of gentle warmth (Svedaja, Uṣṇaja, dāniṣamaśakādayah)" ²⁶ or the maggots or other worms originate in the rainy season due to the atmospheric moisture in the constituent particles of curds and the like and begin to live and move in so short a time.²⁷

Āchārya Haribhadra Sūri has refuted Bhūtacaitanyavāda of the Materialists long before the Sāṃkhya in the following manner. It is the doctrine of the Materialists that this world is formed of only five great elements (mahābhūtas), viz. earth, etc. and there is no existence of soul nor the unseen force anywhere in the world.²⁸

The other Materialists maintain the view on the contrary that elements are non-conscious (acetana). Consciousness is not the character of elements nor the result of elements, while soul is the name of that tattva (reality) with which (soul) consciousness is related (as character or result).²⁹

If consciousness would have been the character (quality) of elements, then it should have been found in all elements at all times, just like

23. " Madaśaktivat vijñānam / pṛthivyādīni bhūtāni catvāri tatvāni / tebhya eva dehākārapariṇatebhyah madaśaktivat caitanyaśūpajayate/" Nyāyamāṇjari, Jayanta, Āhnika, 7. p. 437 ff.
24. " Padmādiṣu prabodhasammilanavat tadvikārah / " Sūtra 19, Āhnika I; Chapter III, Gautama's Nyāyā Sūtra, p. 169.
25. " Ayaso ayaskāntābhigamanavat tadupasarpaṇam." Ibid., Sūtra 22, p. 171.
26. Positive Sciences of the Ancient Hindus, Dr. B. N. Seal, p. 239.
27. " Varṣāsu ca svedādinā anatidaviyasaiva kālena dadhyādyavayavā eva calantah pūtanādikṛmirūpā upalabhyante/", Nyāyamaṇjari, Āhnika 7, Bhūta-Caintanypakṣa, p. 440; The positive Sciences of the Ancient Hindus, p. 240.
28. Pṛthivyādimahābhūtakāryamātramidaṁ jagat /
Na cātmādṛṣṭasadbhāvam manyante Bhūtavādinah // Śāstra-Vārtāsamuccaya, Haribhadrasūri, 1st stabaka, v. 30.
29. " Acetanāni bhūtāni na taddharmo na tatphalaṁ /
Cetanā asti ca yasyeyam sa evātmeti cāpare // ", Ibid., v. 31.

that the existence (existentiality), etc. (general character) and hardness, etc. (particular character) are found in the elements at all times in which they are found.³⁰

Now Haribhadra Sūri refutes Bhūtacaitanyavāda in this way that consciousness exists in elements as force (śakti), for this reason it is not perceptible, but consciousness existing in elements as force cannot be said to be non-existing in elements.³¹

This force (śakti) and consciousness are either non-different by all means from each other or different by all means from each other. If they are non-different, then this force becomes consciousness and if they are different, consciousness should be related with something else.³²

Again, the point of non-manifestation of cetanā (consciousness) does not seem to be logical, because there is no other entity (Vastu), covering consciousness and it is for this reason that the number of realities will go against the doctrine of the Materialists on the admission of the existence of such an entity.³³

Haribhadra Sūri further advances the argument to refute the contention of the Materialists that this thing is directly proved that the element has got the nature of these two qualities or characters – hardness and non-livingness and when consciousness is not of the nature of these two characters (i. e., cannot exist with these two), then how can it be accepted that it was born out of elements ?³⁴

If consciousness does not exist in individual (i. e. uncombined elements), then it cannot exist in the combined elements just as (like that) oil cannot exist in sand particle. And if consciousness exists in the combined elements, then it should exist also in individual elements³⁵ and so on.

30. Yadiyam bhūtadharmaḥ syat̄ pratyekam̄ teṣu sarvadā /
upalabhyeta sattvādikāḥinatvādayo yathā // Ibid., v. 32.
31. Śaktirūpeṇa sā teṣu sādā'to nopalabhyate /
Na ca tenāpi rūpeṇa satyasatyeva cenna tat̄ // Ibid., v. 33.
32. Śakticetanayoraikyam̄ nānātvam̄ vā'tha sarvathā /
Aikye sā cetanaiveti nānātvē anyasya sā yutāḥ // Ibid., v. 34.
33. Anabhivyaktirapyasyā nyāyato nopalabhyate /
Ābṛīrṇa yadanyena tattvasaṁkhyāvirodhataḥ / Ibid. V. 35.
34. Kāṭhinyābodharūpāṇi bhūtānyadhyakṣasiddhitah /
Ceṭanā tu na tadrūpā sā khthām̄ tatphalaṁ bhavet // Ibid., v. 43.
35. Pratyekamasat̄i teṣu na syād reṇutailavat̄ /
sat̄i cedupalabhyeta bhinnarūpeṣu sarvadā // Ibid., v. 44

In conclusion Haribhadra Sūri maintains the view after refuting the doctrine of Bhūtacaitanyavāda of the Materialists with his cogent arguments that the existence of force (Sakti), etc. in soul and of the unseen force (adṛṣṭa), which makes the possibility of sakti etc. in soul, should be accepted and this unseen force (adṛṣṭa), which is different from soul, is real and of many kinds and comes into relation with soul.³⁶

The Sāṃkhya makes the reply to the materialists' view on caitanya in the following manner that "the intoxicating power in liquor is a force, i. e., a tendency to motion. This force is the resultant of the subtle motions present in the particles of the fermented rice, molasses, etc. A motion or a tendency to motion, can in this way be the resultant of several other motions or tendencies."³⁷ "But caitanya (consciousness) is not a motion, and cannot be the resultant of (unconscious) natural forces or motions. Neither can the consciousness of the Self, or of the organism as a whole, be supposed to be the resultant of innumerable constituent particles of the body. One central abiding intelligence is simpler and therefore more legitimate hypothesis than an assemblage of consciousness latent in different bhūtas or particles."³⁸

The Sāṃkhya philosophy maintains the view that Prāṇa (life) is not Vāyu (biomechanical force) nor it is mere mechanical motion generated from the impulsion of Vāyu.³⁹

The five vital forces, viz. Prāṇa, apāṇa, samāna, udāna and vyāna⁴⁰

36. Tasmāt tadātmano bhinnam saccitraṁ cātmayogi ca /
Adṛṣṭamavagantavyam tasya sāktyādisādhakam // Ibid., v. 106.

37. "Madaśaktivat cet pratyekaparidṛṣṭe sāmhatye tadudbhavaḥ" Sāṃkhya Sūtra 22, Chapter III. "Nanu yathā mādakataśaktih pratyekadravyāvṛttirapi militadravye varttate, evam caitanyamapi syāditi cenna pratyekaparidṛṣṭe sati sāmhatye tadudbhavaḥ sambhavet / Prakṛte tu pratyekaparidṛṣṭatvam nāsti /.....nanu samuccite caitanyadarśanena pratyekabhūte sūkṣmācaitanyaśaktiranumeyā iti cenna anekabhūteṣu anekacaitanyaśaktikalpanāyām gauravena lāghayādekasyaiva nityacitsvarūpasya kalpanaucityāt / " Sāṃkhya pravacanabhāṣya, Vijñānabhikṣu, p. 18. cf. also "Bhūtagatavīśeṣaguṇānām sajātiyakāraṇaguṇajanyatayā kāraṇe caitanyam vinā dehe caitanyaśaṁbhavat / " Ibid.

Madye madaśaktirna guṇaḥ madyārambhakānām piṣṭaguḍamadhvādinām yat yasya karma tat karmabhirārabdhām svasvakarmavirodikarma yaducyate prabhāvā iti / Caitanyādikām na karma // Gaṅgādhara's Jalpalatara, 1867, Calcutta, Vide Positive Sciences of the Ancient Hindus. Dr. B. N. Seal, p. 241.

38. Vāyuvat sañcārāt vāyavaḥ prasiddhāḥ / asmākam nāyam niyamaḥ yadindriyavṛttih kramenaiva bhavati naikadā jātisāṅkaryasya asmākam adoṣatvāt / sāmagrisama-vadhāne sati anekairapīndriyaiḥ ekadaikavṛttiutpādane bādhakam nāsti ", Pravacanabhāṣya. Ch. II, sūtra 31. 32, p. 88.; Manodharmasya kāmādeḥ, prāṇakṣobhatayā sāmānādhikaraṇyenaiva aucityāt ", Ibid.

are stated to be Vāyu in metaphorical way. Prāṇa (life) is in reality a reflex activity, a resultant force of the various concurrent activities of the Antaḥkaraṇa, i. e. "of the sensorimotor (Jñānedriya-Karmendriya), the emotive (manah) and the apperceptive reactions of the organism."⁴⁰

According to Vijnānabhikṣu, this explains the disturbing effect on the vitality of pleasurable or painful emotions (like love = kāma) of mind (manas), one of the internal senses involved in the reactions of the living organism.⁴¹

Thus Prāṇa of the Sāṃkhya is not a Vāyu nor is it evolved from the inorganic matters (Bhūtas), "but it is only a complex reflex activity (Sambhūyaikā vṛtti) generated from the operations of the psycho-physical forces in the organism."⁴²

In agreement with the Sāṃkhya the Vedāntists hold the view that "Prāṇa is neither a vāyu nor the operation of a vāyu."⁴³ But they differ from the former's view that Prāṇa is a more reflex or resultant

39. Sāmānyakaraṇavṛttih prāṇādyā vāyavaḥ pañca / Sāṃkhyadarśana, chapter II, Sūtra 31; Sāṃkhyakārikā, 29.

Prāṇa, breath, the ordinary inspiration and expiration; apāna, downward breath, the air or vital force acting in the lower parts of the body; samāna, collective breath, so named from conducting equally the food, etc. through the body; udāna ascending breath, the vital force that causes the pulsations of the arteries in the upper portions of the body from the navel to the head, and vyāna separate breath, "by which internal division and diffusion through the body are effected" (Gauḍapāda, Wilson, p. 105).

This is not very intelligible, but as vyāna is connected in the Sāṃkhya-Tattva-Kaumudi with the skin, the subtle nerve-force by which sensibility is given to the skin or outer surface of the body is probably meant. It is also connected with the circulation of the blood along the surface, the great arteries being under the action of udāna (71) (In the Ātmabodha "Knowledge of the soul", a Vedic poem as assigned to the great commentator Śaṅkarāchārya, the soul is said to be enwrapped "in five investing sheaths or coverings" (Kosh cf. Fr. Cosse, Ir. Gael Coch-al, a pod or husk). The third of these is called prāṇamaya, i. e. "the sheath composed of breath, and the other vital airs associated with the organs of action" (Indian Wisdom, p. 123), Vide the Sāṃkhyakārikā of Iṣvara Kṛṣṇa, ed. by John Davies, p. 46.

40. Positive Science of Ancient Hindus. p. 241.

41. "Mano dharmasya kāmaḍeh / prāṇakṣobhakatayā sāmānyādhikaranyenaiva au-cityāt," Sāṃkhy Pravacanabhaṣya, Chapter II, 31, p. 88.

42. "Karaṇāni niyatavṛttayah santah sambhūyaikām prāṇākhyām vṛttim pratipadyante (pratilapsyante), Śaṅkarabhaṣya on Brahmaśūtra, Ch. II. Pāda 4, Sūtra 9.

"Sāmānyakaraṇavṛttih prāṇādyā vāyavaḥ pañca /" Sāṃkhyakārikā, Iṣvara Kṛṣṇa, 29; see also Sāṃkhyapracavacanabhaṣya, chapter II, Sūtras 31,32.

43. "Na vāyukriye pṛthagupadeśat /" Brahmaśūtra, chapter II. pāda 4, Sūtra 9; see its Bhaṣya,

of concurrent sensori-motor, emotive and apperceptive reactions of the organism. If eleven birds, put in a cage, concurrently and continually strike against the bars of it in the same direction, it may move on under the impact of concerted action. But the sensory and motor activities cannot in this way produce the vital activity of the organism, because the loss of one or more of the senses does not result in the loss of life. This is above all the radical distinction between them. There is the sameness of kind (Samajātiyatva) between the motions of the individual birds and the resultant motion of the cage, but Prāṇa is not explained by sensations, but it is a separate principle (or force), just as the mind and antaḥkaraṇas generally are regarded in the Sāṃkhya. It is a sort of subtle "ether-principle" (adhyātmavāyū) pervasive of the organism, not gross vāyu, all the same subtilized matter like the mind itself, as everything other than the soul (ātmā), according to the Vedānta, is material (jāḍa). Prāṇa is prior to the senses, for it regulates the development of the fertilized egg, "which would putrefy, if it were not living, and the senses with their apparatus originate subsequently from the fertilized egg."⁴⁴

Caraka⁴⁵ explains vāyu as the impelling force, the prime-mover, which sets in motion the organism, the organs (including the senses and the mind), arranges the cells and tissues, unfolds or develops the foetal structure out of the fertilized ovum. According to Caraka and Śuśruta,⁴⁶ there are five chief vāyus with different functions for the

44. Also Vācaspati Miśra, Bhāmatī Tīkā as follows :

"Siddhāntastu na samānendriyavṛttih prāṇah // Sa hi militānām vā vṛttibhavet pratyekam vā / na tāvत् militānām ekadvitricaturindriyābhāve tadabhbhāvaprasāṅgāt / na khalu cūrṇahridrasāmyogajanmā, aruṇaguṇastayoranyatarābhāve bhavitumarhati / na ca bahuviśiṣṭasādhyām śibikodvahanānām dvitriviśiṣṭasādhyām bhavati / na ca tvagekasādhyām / tathā sati sāmānyavṛttitvānupapatteḥ / api ca yat sambhūya kārakāṇi niṣpādayanti tat pradhānavyāpārānuguṇāvāntaravayāpāreṇaiva / yathā vayasām prātisviko vyāpāraḥ piñjaracalanānuguṇaḥ / iha tu śravaṇādyavāntaravayāpāropetāḥ prāṇaḥ na sambhūya Prāṇyuriti yuktām pramāṇa-bhāvādatyantavijātiyatvācca śravaṇādibhyāḥ prāṇānasya / tasmādanyo vāyukriyābhām prāṇaḥ / Vāyurevāyamaḍhyātmamāpannaḥ mukhyo, api prāṇaḥ // ". Ibid (Śāṅkarabhāṣya). cf. also Jyeṣṭhaśca prāṇaḥ śukraniṣekākādarabhyā tasya vṛttilābhāt / na cet tasya tadānām vṛttilābhāḥ syāt yonau niṣkātām śukrām pūyeta na sambhaved vā / śrotrādināntu karnaśaṣkulyādīsthānavibhāgani-ṣpattau vṛttilābhāṇa jyeṣṭhatvām / ". Śāṅkarabhāṣya, Chapter II, pāda 4, Sūtra 9.

45. "Vāyuh tantrayantradharaḥ, prāṇāpānodaṇasamānāvāyānātmā pravartakah ceṣṭā-nām, prāṇetā māhasaḥ sarvendriyānām udyotakah, sarvaśārīradhātuvyūhakaraḥ, sandhānakaraḥ śarirasya, pravartako vācaḥ, harsotsāhayoryonih. kṣeptā bahir-malānām. karta garbhākṛtinām prāṇāpānodaṇasamānāvāyānātmā /" Caraka. Sūtrasthāna, ch. XII.

46. Caraka, Sūtrasthāna, chapter XII and Suśruta, Nidānasthāna, chapter I.

maintenance of the animal life, viz. prāṇa, udāna, samāna, vyāna and apāna, as mentioned in the Sāṃkhya. Śuśruta⁴⁷ describes prāṇa as having its course in the mouth and function in deglutition, hiccup, respiration, etc., udāna in articulation and singing, samāna as digesting the food substance in the stomach in conjunction with the animal heat, vyāna as causing the flow of blood and sweat, and apāna with its seat in the intestinal region as throwing out the urinogenital secretions.⁴⁸

In the mediaeval philosophy⁴⁹ there is mention of forty nine vāyus among which there are ten chief Vāyus, viz. (1) Prāṇa, (2) Apāna, (3) Vyāna, (4) Samāna, (5) Udāna, (6) Nāga, (7) Kūrma, (8) Kṛkara or Krakaro, (9) Devadatta and (10) Dhanañjaya.⁵⁰

Prāṇa has the function in the ideo-motor verbal mechanism and vocal apparatus, the respiratory system, the muscles in coughing, singing, etc., apāna in ejecting the excretions and wastes, the urine, the faeces, the sperm and germ-cells etc., vyāna in extension, contraction, and flexion of the muscles, tendons, and ligaments, the stored up energy of the muscles, udāna in maintaining the erect posture of the body, nāga in involuntary retching and vomiting, kūrma in the automatic movement of the eyelids, winking, etc., kṛkara in the appetites, hunger and thirst, devadatta in bringing about yawning, dozing, etc. and dhanañjaya in causing coma, swooning and trance.⁵¹

47. Suśruta-Nidānasthāna, chapter I.

“Teṣām mukhyatamāḥ prāṇah ... /sabdoċċāraṇāniḥsvāsocchvāsa kāśādikāraṇāmṛt apāṇāḥ asya mūtrapuriśādīvisargaḥ karma kirttītām /vyāṇāḥ .. prāṇāpanadhṛtit-yāgagrahaṇādyaḥasya karma ca/samāno’pi vyāpya nikhilam śarīram vahninā saha / dvisaptati sahaśreṣu nāḍirandhreṣu saṁcaran bhuktapītarasān samyagānayan deha puṣṭikrt / udānah karmāśya dehonnayanotkramāṇādi prakīrttītām // tvagā-didhatunāśruya pañcanāgadayaḥ sthitāḥ udgārādi nimeṣadi ksutipipāśādikām kramāt / tandrāprabhṛti mohādi (sophādi) teṣām karma prakīrttītām /” Saṅgītaratnākara, Sāraṅgedava, vv. 60-67, chapter I. Vol. I.. pp. 41-42.
cf. the summary in Raja Sourindra Mohan Tagore's edition of the Saṅgīta-darpaṇa. See also Kalyāṇakāra. 3. 3. p. 32.

48. Vide the Positive Sciences of the Ancient Hindus, p. 230.

49. Unapañcādāśadadvāyurudite putrāḥ / te sarve apajāḥ indreṇa devatvām prāṇitāḥ śarīrāntarbāhyabhedena daśadhā /” Bhāgavataḥikāyām Śridharasvāmin, Vide Śabdakalpadruma. 4th Kāṇḍa, p. 342.

50. Prāṇāpānau tathā vyānasamānōdānasamjñākāḥ / Nāgarām Kūrmām ca Kṛkara m Devadattām Dhanañjayam // Saṅgītaratnākara, Ch. I, V. 59, p. 41, Vol. I.

“Prāṇāpānau tathā vyānasamānōdānasamjñākāḥ / Nāgaḥ Kūrmeca Kṛkaro Devadattadhanañjayau //” Saṅgītadarpaṇam of Catura Dāmodara, Ch. I, V. 50.

51. Saṅgītaratnākara. Vol. I, ch. 1, vv. 60-67, pp. 41-47,

“Sabdoċċāraṇām (vāñniśpattikāraṇām) niḥsvāsaḥ ucchvāsaḥ (antarmukhaśvāsaḥ) tandrādinām kāraṇām (sādhanām) prāṇavāyuh, / Vinmūtraśukrādivahatvōmapānasya karma, ākuñcanaprasāraṇādi vyānasya karma jneyām / aśitapītādinām samatānāyanadvātā śarīrasya posaṇām samānasya karma / udānavāyuh ūrddhvānayanameva

The study of the different views on Prāṇa or Vāyu shows that Jaina paryāpti or prāṇa is neither a result of peculiar chemical combinations of non-living matter as advocated by the Cārvākas nor a complex activity of the Sāṃkhya but a sort of separate principle (adhyātma vāyu) pervasive of the organism as defined by the Vedānta, an impelling force, the prime-mover of Caraka and Śūrata. It appears to be the actual living material of all plants and animals like protoplasm of modern Biology. Jaina paryāpti and prāṇa, the two unique forces, not explainable in terms of Physics and Chemistry, are associated with and control life. The concept of these forces may be called vitalism which contains the view that living and non-living systems are basically different and obey different laws. Many of the phenomena of life that appear to be so mysterious in Jaina Biology may be explained by physical and chemical principles with the discovery of future research in this field. So it is reasonable to suppose that paryāpti, a mysterious aspect of life, although not identifiable with protoplasm, comes nearer to the latter because of its unique functions in the organisms.

According to modern Biology, "protoplasm is the actual living material of all plants and animals. This is not a single substance but varies considerably from organism to organism, among the various parts of a single animal or plant, and from one time to another with a single organ or part of an animal or plant. There are many kinds of protoplasm, but they share certain fundamental physical and chemical characteristics."⁵²

"The protoplasm of the human body and of all plants and animals exists in discrete portions known as cells. These are the microscopic unit of structure of the body, each of them is an independent, functional unit, and the processes of the body are the sum of the co-ordinated functions of its cells. These cellular units vary considerably in size, shape and function. Some of the smallest animals have bodies made of a single cell; others such as, a man or an Oak tree are made of countless billions of cells fitted together."⁵³

"The major types of organic substances found in protoplasm are

asya karma, nāgādayaḥ nāgakūrmakṛkara-devadattadhanañjaya-rūpāḥ pañcavāyavaḥ / eteṣāṁ karmāṇi ca yathākramāṇi udgāronmīlanakṣudhājananavijñāmbhaṇamoharūpāṇi /" Saṅgitadarpaṇa, chapter I, sloka 41-48.

cf. "Prāṇaḥ prāgyāttirucchvāsādikarmā / Aśāṇaḥ avāgyāttirutsargāpikarmā / Vyāṇaḥ tayoḥ sandhau vātāṇaḥ vīryavatkarmahetuḥ / Udāṇaḥ ūrddhvavrttiḥ ūtkrāntyādi hetuḥ / samāṇaḥ samāṇaḥ sarveṣu aṅgeṣu yaḥ annarasān nayati / iti /." Saṅkarabhaṣya, chapter II, pāda 4, sūtra 2. Vide Positive Science of the Ancient Hindus, p. 230-31.

52. Biology. p. 16.

53. Ibid.

carbohydrates, proteins, lipids, nucleic acids and steroids."⁵⁴ Some of these are required for the structural integrity of the cell, others to supply energy for its functioning and still others are of prime importance in regulating metabolism within the cell."⁵⁵

"Carbohydrates and fats (lipids) have only a small role in the structure of protoplasm but are important as sources of fuel; Carbohydrates are readily available fuel, fats are more permanently stored supplies of energy. Nucleic acids have a primary role in storing and transmitting information. Proteins are structural and functional constituents of protoplasm, but may serve as fuel after deanimation. The body can convert each of these substances into others to some extent, Protoplasm in a colloidal system, with protein molecules and water forming the two phases, and many of the properties of protoplasm—muscle contraction, ameboid motion, and so on—depend on the repaid change from sol (liquid condition) to gel (solid or semi-solid) state and back."⁵⁶

54. Ibid, pp. 25-26.

55. Ibid.

56. Ibid., p. 33.

(Second Section)

Characteristics of Living Substances (Jivadravyas)

All living substances have, to a greater or lesser extent, the properties of specific size¹ and shape,² metabolism,³ movement,⁴ irritability,⁵ growth,⁶ reproduction⁷ and adaptation.⁸ This list of their properties seems to be specific and definite, but the line between the living and

1. Bhagavati Sūtra, 19.3.652-51; 25. 1. 717; Uttarādhyayana Sūtra, 36-70 (Sūkṣma-bādara etc.). Paññavaṇā (Sūkṣma-bādara, etc.); Gammaṭasāra (Jivakāṇḍa), V. 177, V. 183.
2. Paññavaṇā Saṁṭhānāidāracchakri 983-989. p. 241; “Samacaurāṁsa, naggoha, sāi, vāmaṇa ya khujja huṇḍa ya / Jivāṇa cha sāṁṭhāṇa /” Bṛhatsaṁgrahaṇi, Candrasūri, VV. 243-5.
“Samacaurasaṇaggohāśādiy, khujjāyavāmanāhuṇḍā /”, Paryāptyadhipikā, Mūlācāra, Pt II, 12 V. 49, Sri Vasunandisiddhānta Cakravarṭti, p. 207; Lokaprakāśa, Vina-yavijaya, Pt. I, 3rd Sarga, vv. 205-10, pp. 98-99.; Gommaṭasāra (Jivakāṇḍa), 201.
3. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3, Āhāranikṣepa varṇana; Bhagavati Sūtra, 1.7.61-62, 7-3. 275-6; Paññavaṇā, Āhārapadaṁ, pajjattidāraṁ, 2nd uddeśaka p. 406.
Taṇḍula Veyāliyam pp. 3-10; Navatattva Prakaraṇam, Dharmavijaya, v. 6, p. 12; Lokaprakāśa Pt. I, 3rd Sarga, vv. 15-21 ff; Gommaṭasāra (Jivakāṇḍa). chapter III, vv. 119-121; Mūlācāra II. 12-4; Tarkarahasyadipika on Saḍdarśanuṣamuccava Guṇaratna. (Jainamatam); V. 49.
4. Ācārāṅga Sūtra, Book I, 9.1.'4 (Adu thāvāra ya tasattāe, tasā ya thāvārattāe); Sūtrakṛtāṅga, śrutasandha II, Adhyayana 2, Sūtra 18, Sūtra 60; Sthānāṅga. 2. 4. 100; Bhagavati Sūtra 25.4.789; Uttarādhyayanasūtra, 36.68; Jivābhigama sūtra. p. 12; Mūlācāra, Pt. I, 30 (226), p. 295, Tattvārtha Sūtra, Umāsvāti, 2.12-14; Tarkarahasyadipikā, Guṇaratna, V. 49.
5. Bhagavati Sūtra 3.9.170; 2.4.99; Paññavaṇāsūtta, Indriyapadaṁ 15, puṭṭhadṇraṁ, etc., Jivābhigamasūtra, Jyotiṣka Uddeśaka; Tarkarahasyadipikā, V. 49.
6. “Ahāvaraṁ purakkhāyāṁ ihegaiyā satta rukkhajoniyā rukkha-aṁbhavā . . . biyattāe viuttāmī, etc.” upto “nāṇavīhasaṁbhava . . . satīrasambhavai.” Sūtrakṛtāṅga Śrutasandha II, Adhyayana 3, Sūtra 55-62.
Bhagavati, 1.7.61-2; 7.3.276: Taṇḍula Veyāliya, vv. 2,3,4 5,6; Tarkarahasyadipikā, V. 49.
7. Sūtrakṛtāṅga, Śrutasandha, II, Adhyayana 3; Bhagavati Sūtra, 7.5.282; Sthānāṅga Sūtra 3.1.179; 7.3.543; Uttarādhyayanasūtra, 36.170; Jivābhigamasūtra 3.1.96 : 1-33; Paññavaṇā sūtra, 1. 58; 68; Mūlācāra II, 12. 43, 44, 45; Tattvārthaśūtra 2. 32; Tarkarahasyadipikā, v. 49,
8. Sūtrakṛtāṅga, Śrutasandha, II, Adhyayana 3; Bhagavati Sūtra, 7.3.275; Paññavaṇā, Sthānāpadaṁ; Jivābhigamasūtra, 1.34, 35, 36; Tarkarahasyadipika, 28, V. 49.
9. Biology, p. 17.

non-living, according to modern Biology, is tenuous, as "non-living objects may show one or more of these properties, but not all of them."¹⁰ Many of the phenomena of life that appear to be so mysterious, as discovered by the Jainācāryas, such as, ucchvāsa (respiration), samjnā (instinct), bhāṣā (speech), Kaṣāya (passion), indriyas (senses), leṣyā (condition of soul or psychic condition), Vedanā (feeling), etc. of the living substances, have proved to be understandable by invoking a unique life-force, while other aspects of life can be explained by physical and chemical principles in the light of future research in the field of Biology.

Specific Organization :

Each kind of living organism is recognized by its characteristic shape and appearance,¹¹ the adult of each kind of organism typically have much more variable shapes and sizes.¹² Living substances are not homogeneous, but are made of different parts,¹³ each with special functions, thus the bodies of living things are characterized by a specific

10. Ibid.

11. Samacauram̄sa naggioha, sāi vāmana ya khujja huñda ya / Jivāna ca saṁhañā /' Bṛhatsaṁgrahāñi, Candasūri, vv. 243-5.; See Pañnavanā, saṁhañadāracchakāñ 983-984, P. 241. Mūlācāra, Pt. II, 12. V. 49, P. 207; Lokaprakāśa Pt. I, 3rd Sarga, vv. 205-210, pp. 98-99; Gommaṭasāra (Jivakāñḍa), 201.

12. Bhagavatī Sūtra, 19.3.652-53; 25.1.717; Uttarādhyayana sātra 36. 70 ff; pañnavanā sūtra, 29.25 (Sūkṣma-bādara, etc.) Gommaṭasāra (Jivakāñḍa) V. 177, V. 183.

13. "Rukkhesu mūlattāe khaṁdattāe khaṁdhattāe tayattāe sālattāe pavālattāe pattattāe pupphaṭṭāe phalattāe biyattāe viuṭṭemti" Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 46; Blood (Soṇīta) Ācārāṅgasūtra, Baok II, 10 (Soṇiyāe); Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3.18; Bhagavatī 1.7.61; Tandulaveyāliya, 2, p. 6. dhamanī and śīrā—arteries and veins; Sūtrakṛtāṅga, Śrutaskandha 2, Adhyayana 2, Sūtra 18 (hiyayāe—heart); Bhagavatī, 1. 7. 61; Tandulaveyāliya, pp. 8-9 (Skin, bone, marrow, hair, beard, hair or body and nail); Sūtrakṛtāṅga II. 2. 18 (accā-body, ajina (skin), māṁsa (flesh), soṇiya = (Blood), hiyāya (heart), pitta (bile).
 Bhagavatī 1. 7. 61 (The respiratory system)
 Bhagavatī 1. 7. 61 (Digestive system)
 Bhagavatī 1. 7. 61-2 (Excretory system)
 Bhagavatī 1. 7. 61: Tañḍulaveyāliya 2, p. 6. (The Integumentary and Skeletal systems)
 Bhagavatī 1. 7. 61 (Out growth of the skin-hair and nail)
 Tañḍulaveyāliya 2, p. 6 (Peśi = muscular system)
 Tañḍulaveyāliya 2, p. 6 (Nervous system)
 Tañḍulaveyāliya, p. 7. sūtra 3 (The sense organs)
 Pañnavanā, Indriyapadāñ, Bhagavatī sūtra 16. 1. 566,
 2. 4. 99, (Sense organs) Bhagavatī 3. 9. 170.
 Pañnavanā, Indriyapadāñ, puṭṭbedāra (Tactile senses) Organs of taste and smell, eye, ear).

complex organization,¹⁴ for each type of cell-body (Abbuya¹⁵) has a characteristic size and shape, it has a unique vital force¹⁶ which distinguishes (or separates) the living substance from the surroundings and it contains a life-force,¹⁷ plans a major role in controlling and regulating the activities of the cell-body. The bodies of the higher animals and plants are organized in a series of increasing complex levels.¹⁸ It appears that cells are organized into tissues, tissues into organs and organs into organ-systems.¹⁹

According to modern Biology, “ The structural and functional unit of both plants and animals is the cell, the simplest bit of living matter that can exist independently. The cell itself has specific organization, for each type of cell has a characteristic size and shape, it has a plasma membrane which separates the living substance from the surroundings, and it contains a nucleus, a specialized part of the cell separated from the rest by a unclear membrane. The nucleus, plays a major role in controlling and regulating the activities of the cell. The bodies of the higher animals and plants are organized in a series of increasingly complex levels. Cells are organized into tissues, tissues into organs, and organs into organs system.”²⁰

Metabolism :

According to Jaina Biology, metabolism is the sum of all the chemical activities of paryāpti (Vital force)²¹ which provide the energy for the growth, maintenance and repair of the organic system as well as its own growth with intensity. Paryāpti of all cell-bodies is constantly

14. Ibid.
15. Tandulaveyāliya, 2. p. 6. Cell = arbuda ?
16. Paryāpti
17. Prāṇa
18. Bhagavatī Sūtra 19. 3. 6. 52-53; 25. 1. 717.
Uttarādhyanā Sūtra 36.70 ff.
Paññavānā 29.25. (Sūksma-bādara, etc.)
Gommaṭasāra (Jiva), VV. 177, 183.
19. Tandulaveyāliya, 2, p. 6.
“ Abbuya jāyae pesi, pesio ya ghaṇam bhave....piṁḍiyāo pāni, pāyām siraṁ ceva
nivvāṭtei, pittasoniyam uvacine satta sirasayāim pañca petisayaiṁ upto romaku-
vakoḍiya nivvāṭtei I ”
20. Biology Villel. A. p. 17.
21. Paññavānā, Āhārapada, 2nd Uddeśaka, pajjattidāra, p. 406.
Jivābhigam, p. 23; Navatattva Prakaraṇam, V. 6, p. 12, etc.
Lokaprakāśa, Pt. I, 3rd Sargā, vv. 15, ff; Gommaṭasāra (Jivakāṇḍa). Paryāpti,
3rd chapter, v. 119, etc.. Mūlācāra, Pt. II, paryāptyadhiṭṭhāra, 12, v. 4 etc.
Bṛnatsangrahaṇi, 363.

changing²² by taking in new substances, altering them chemically in a variety of ways, building new vital force or energy²³ and transforming²⁴ the potential energy contained in large molecules of nutrients or chyle (rasa)²⁵ into kinetic energy (śakti) including heat as these substances are converted into other simpler substances. This constant expenditure of energy is one of the unique characteristics of living substances.

Both plants and animals have anabolic²⁶ and catabolic²⁷ phases of metabolism. They occur continuously and simultaneously.²⁸ Plants,²⁹ however, (with some exceptions),³⁰ have the ability to manufacture their organic compounds³¹ out of inorganic materials in the soil and air, animals must depend on plants, for their food. "Plant cells are simply better chemists than animal cells."³²

Movement:

The ability to move³³ is the third characteristic of living substances.

22. Ibid. *Malayagiri*
"Ahārasarjra īmdiya, usāsa vao maṇo abhinivatti,
hoi jao daliyāo Karanām Pai sa u pājjatti" (*Bṛhatsaṁgrahaṇi*, p. 1:0)
"Āhāraśarirendraiyoçchvāsa vā comanasambhinirvātirbhiniśattiryato dalikāddalab-
ūtāt pudgalasāmuhāttasya dalikasya śaktirūpām sa paryāptih 1, vide *Navatattva*
Prakaraṇām, *Tīka*, p. 13.
23. "Tatra Jivāḥ pudgalopacayaśalambanena; samutpānnayā yayā śaktyā nānāmāhāra-
mādaya khalarasārūpātayā pariṇamayati sa āhārāpārāptih .. Jivāḥ pudgalonicaya-
jatayā yayā śaktyā Punaramanoyapudgaladravyamādaya manastvena pariṇamayaya
śalambya ca visṛjati sa manāḥparyāpti" I Ibid, pp. 13-4, etc.
24. Ibid.
25. Ibid.
26. "Anabolism refers to those chemical processes in which simpler substances are
combined to form more complex substances, resulting in the storage of energy
and the production of new protoplasm and growth." Biology, p. 17.
27. "Catabolism refers to the breaking down of these complex substances, resulting
in the release of energy and the wearing out and using up of protoplasm,"
whose place is taken by paryapti in Jain Biology." Biology, p. 17.
28. Pājjattipāṭīhavaṇām jugavaṇām tu kameṇa hodi niṭhavaṇām / aṁtamuhuttakāleṇa-
hiyakamā tattiyālavā" 120, *Gommaṭasāra* (*Jīva*), 120; Biology, p. 18.
29. Bhagavati Sūtra, 7.3.275-6., Biology, p. 18.
30. Prasitic plants which are born on trees have no ability to manufacture their
organic compounds, but they feed on the sap of the supporting plants. See
Sūtrakṛtāṅga, *Śrutasandha* 2, *Adhyayana* 3, Biology, p. 18.
31. Bhagavati, 7.3.275-6; *Tarkarahasyadīpikā* 49; Biology, p. 17; *Guṇaratna*, p. 157.
32. Biology p. 18.
33. Ācārāṅga Sūtra, Book I, p. 1.14; *Sūtrakṛtāṅga*, *Śrutasandha* II, *Adhyayana* 2,
Sūtra 18; *Sthānāṅga* Sūtra 2.4.100; Bhagavati Sūtra, 25.4.739; *Uttarādhyayana*
Sūtra 36.68; *Jivabhiṣagama* Sūtra, p. 12; *Tattvārtha* Sūtra II, 12.14; *Mūlācāra*,
Pt. I, 30 (226); *Jivavicāra*, 2; *Tarkarahasyadīpikā* v. 49; *Gommaṭasāra* (*Jīva*) 3',
Pannavānā, *Kāyadāra*, 4.232, p. 86.

The movement of animals³⁴ is quite obvious. According to Jain Biology, all the five one-sensed beings, viz. four earth quadrates and plant are sthāvara (immobile)³⁵ as they cannot move from place to place. There is one view that the earth-bodied being, the water-bodied being and plant are sthāvara (immobile)³⁶ but the fire-bodied being (agnikāyikajiva) and the wind-bodied being (vāyukāyikāyiva) are trasa (mobile)³⁷ from the point of view the movement of fire and wind. According to Guṇaratna,³⁸ plant-life also has various kinds of movement or action connected with sleep, waking, expansion and contraction in response to touch, also movement towards a support or prop. That is to say, the movement of plants is much slower and less obvious but is present nonetheless, as explained in modern Biology,³⁹ although they are called sthāvara (immobile).⁴⁰

According to modern Biology, "A few animals-sponges, corals, oysters, certain parasites-do not move from place to place, but most of these have cilia or flagell to meet their surroundings past their bodies and thus bring food and other necessities of life to themselves. Movement may be the result of muscular contraction, of the beating of the microscopic protoplasmic hairs called cilia or flagella, or of slow oozing of a mass of protoplasm (ameboid motion). The streaming motion of the protoplasm in the cells of the leaves of plants is known as cyclosis."⁴¹ It is to be noted here that corals,⁴² a class of prthivikāyikajivas

34. Ibid.; Biology, p. 18.

35. Paññavanā, Kāyadāra, 4. 232, p. 86.

"Puḍhavijalaṇavā, Vanassai thāvara ḡeyā 1" "Jivavicāra; " Labdhyā prthivya-
ptejoवायुवानापतयाः sarve sthāvarānām karmodayat sthāvarā eva ", Tattvārtha
Sūtra (Comm.), 2-14, p. 161.

36. Ibid., Sthānāga 3; 1.164, Uttarādhyana Sūtra, 36.69. "Puḍhavijalaṇavā, Vanassai thāvarā ḡeyā 1" "Jivavicāra 2." " Labdhyā prthivya-
ptejoवायुवानापतयाः sarve sthāvarānām Karmodayat sthāvarā eva " 1, Tattvārtha Sūtra (Com.) 2 14
p. 161.

37. Ibid ; Uttarādhyayana Sūtra 36.107. Tattvārthasutrā, 2-14; See Commenta y
"Ataḥ Kriyām prāpya tejoवायवोत्रसत्वाम," p. 161.

38. "Vanaspatayah sacetāna-bālakumāra = Vṛddhāvasthā (1) pratiniyatavṛddhi
(2) svapraprabodhasparśadhetukollāsasāmkocāśrayopasarpaṇādiviśiṣṭānekakriya
(3) Chimavayavamalaṁ (4) Pratiniyatapradeśāhāragrahaṇa (5) Vṛkṣayurvedābhīhi-
tayuskistanistāhāradinimittakavṛddhīhāni (6 - 7), Āyurvedoditativāttadroga
(8) Viśiṣṭāusadhaprayogasampāditapravṛddhīhānik satabhagnasāṁrohana (9) prati-
niyataviśiṣṭāśarīrasaviryasnigdhatvarūkṣatva. (10) Viśiṣṭādanahārda (1) dimattvān-
yathānupapatteḥ," 1. (3). Tarkārabasyadipika (Jainamatam), v. 59. Commentary
by Guṇaratna., p. 159. Saddarsana Samuccaya, (Circa 1350 A. D.)

39. Biology, p. 18.

40. See Ācārāṅga Sūtra Book I. 9.1.14, etc.

41. Biology, p. 18.

42. Uttarādhyayana Sūtra, 86, 74-75.

do not move from place to place like sponges and corals of modern Biology.⁴³ So it is a thought-provoking idea to note that the Jain view of movement of beings is well supported by modern Biology to a considerable extent.

Irritability :⁴⁴

Living beings are irritable, they respond to stimuli⁴⁵ – physical or chemical changes in their immediate surroundings. Stimuli which are effective in evoking a response in most animals and plants are changes in colour,⁴⁶ intensity⁴⁷ or direction of light,⁴⁸ changes in temperature⁴⁹ pressure or sound,⁵⁰ touch⁵¹ and changes in the chemical composition of earth, water, or air surrounding the organism.

In Jaina Biology it is started that the five sense-organs are endowed with infinite points (ananta pradeśikas), i. e. infinite cells, and innumerable extension (asasīkheya pradeśāvagādhas),⁵² sensation or irritation in human brain is caused by the stimuli of the five sense-objects (indriya-viṣaya)⁵³ received from outside, when the sense-organs come into contact with them directly or indirectly. So it is explained that the ear hears the touch and entered sounds into it, the eyes see the untouched (apuṭṭha) and unentered (appaviṭṭha) sense-objects (i. e. the images of the sense-objects perceived by the eyes reflect on the

43. Biology, p. 18.

44. Bhagavatī Sūtra, 3.9.170; 2.1.99; Paññavānā, Indriyapadām 15, Puṭṭhadāra, etc.; Jivābhigama, Jyotiṣka Uddesaka; Tarkarahasyadipikā (Jainmatām), V. 59, Tīkā by Guṇaratna.

45. "Lajjalūprabhṛtināṁ hastādisaṁsparsā'patrasaṁkocādika parisphuṭakriyopalabhyate 1", Ibid., (Tarkarahasyadipikā), V. 59 (Tīkā).

46. "apuṭṭhām rūvām pasati", Bhagavatī, 2.4.4.99.

Paññavana, Imdriyapadām I, Puṭṭhadāram, Sūtra 990.

"appaviṭṭhām rūvām pasati", Paññavānā, Ibid., Sūtra 19.

47. Bhagavatī, 2.4.99; Paññavānā, Indriyapadām, 154, Uddesaka, Visayadāram, Sūtra 992.

48. For example, Sunflower (Suryamukhi) moves according to the direction of the light of the Sun. See Biology, C. A. p. 18.

49. Bhagavatī, 2.4.99; Paññavānā, Indriyapadām, I, Puṭṭhadāram, Sūtra, 920 Paviṭṭhadāram Sūtra, 991.

50. Tarkarahasyadipikā, V. 49 "Lajjalūprabhṛtināṁ hastādisaṁsparsāt-patrasaṁkocādikaparisphuṭakriyā upalabhyate."

51. "Putthām saddāim suṇei....!", Bhagavatī Sūtra, 2.4.99; See also Paññavana Sutta, Indriyapadām, Puṭṭhadāram.

52. Bhagavatī, 2. 4. 99; Paññavānā, Indriyapada, 1st.

Uddesaka, Suttas, 983-939.

53. Bhagavatī, 2. 4. 99; Paññavānā, Indriyapadām 1st.

Uddesaka, Viṣayadāram, Sutta. 992.

retina so that they can see them). According to modern biology, light sensitive cells exist in almost all living matter from protozoa to man.⁵⁴ The nose smells the touched and entered objects and the skin experiences the touch of touched and entered objects.⁵⁵

This Jain view of sensation or irritability of beings is supported by Modern Biology to some extent which explains that "In man and other complex animals, certain cells of the body are highly specialized to respond to certain types of stimuli; the rods and cones in the retina of the eye respond to light, certain cells in the nose and in the taste buds of the tongue respond to chemical stimuli, and special cells in the skin respond to changes in temperature or pressure."⁵⁶ Gujaratna observes the sensitivity or irritability of plants like the *Mimosa pudica* (Lajjavatilatā) to touch, "which show a manifest reaction in the form of contraction."⁵⁷ According to modern Biology, the irritability of plant cells is not always so apparent as that of animal cells, but they are sensitive to changes in their environment. Protoplasmic streaming in plant cells may be speeded or stopped by changes in the amount of light. A few plants, such as the venus flytrap of the Carolina swamps, have a remarkable sensitivity to touch and can catch insects."⁵⁸

The Jaina view on the sensitiveness or irritability of living beings suggests their response to stimuli, physical or chemical changes in their surroundings, which are effective in evoking a response in most animals and plants, e. g. eye responds to light, certain cells in the nose to smell and the taste buds of tongue to chemical stimuli and special cells in the skin respond to changes in touch or temperature or pressure and ear to sound.⁵⁹

Growth :⁶⁰

Growth means those processes which increase the amount of living substance of the body, measured by the molecules of nutrient or chyle

54. Bhagavati, 2. 5. 97; Pañnavanā, Indriyapadām 1*, 1st Uddesaka, Puṭṭhadām, Pavitthadārm, Sutra, 990 1, p. 241.

55. Ibid.

56. Biology, p. 18.

57. Lajjalūprabhṛ̥tinām hastādisaṁsargāt (saṁsparśāt) yatra tāṁkocādikaparisphuṣa-kriyā upalabhyate 1" Tarkarahasyadīpiā on V. 49, Gaṇkratna, p. 58. Vide the positive Sciences of the Ancient Hindus, p. 174.

58. Bioiology, p. 18.

59. Bhagavati, 2. 4. 99; Pañnavanā, Indriyapadām 15, 1st Uddesaka, Puṭṭhadaram and pavitthadaram 9.0-1, Visayadaram, 992.

60. Sūtrākṛtāṅga, Śrūtaskandha II, Adhyaya 3, Sūtra 55-66.; Bhagavati, 1.7.61-2; Tandulaveyaliya VV. 2-6; 7.3.2-6.; Tarkarahasyadīpikā V. :9, Guṇaratnaṇikā.

(rasa)⁶¹ or sap present, i. e. "nitrogen or protein present" according to modern Biology.⁶² It is the characteristic of all living beings including plants. The processes of growing life of plants involve the stages of infancy, youth and age and regular growth⁶³ etc. like those of other beings.

Growth may be uniform in the several parts of an organism or it may be greater in some parts than in others so that they proportionally change as it occurs. Some organisms, e. g. most trees, will grow indefinitely,⁶⁴ while most animals have a definite growth period which terminates in an adult⁶⁵ of a characteristic size. One of the remarkable aspects of the growth process is that each organ continues to function, while undergoing growth.⁶⁶ The growth process of beings takes place by assimilation of suitable food.⁶⁷

According to Śankara Misra, the growth of organs (or tissues) by natural recuperation after wounder of laceration is an additional charactersitic.⁶⁸

Modern Biology explains that "growth may be brought about by an increase in the size of the individual cells or by an increase in the number of cells, or both."⁶⁹

Reproduction :⁷⁰

The ability to reproduce is the sine qua non of life in a being—

61. Navatattvaprakaraṇam, V. 6, pp. 12. 13.
Lokaprakāśa, Pt. I, 3rd, Sarga, VV. 15 ff; Brhatsaṅgrahaṇī, 364, p. 130.
"Tatra yayā śaktya kāraṇabhūtaya bhuktamāhāraṇam Khālarasarūpatayā kartum samar�o bhavati... yayā rasibhūtamābāraṇam rasāśigmam samedo, asthimajāśukra-lākṣaṇasaptadhātūrūpatayā paniṇamayati... 1" Brhatsaṅgrahaṇī, 363, p. 130.
62. Biology, p. 18.
63. Tarkarahasyadipikā V. 49, p. 159, Tīkā "Bālakumāra-vṛddhāvastha qratiniyatavṛddhiḥ" etc.
64. According to the Uttarādhyayana, the period of ten thousand years is the longest duration of the life of plants and the period of infinite years is the longest duration of life of plants which are called pānaka, not learning that plant-body. "Aṇāṁtakālamukkosa ... Kāyaṭhī paṇagāṇam, tāṁ kāyam tu amūṁcao". Uttarādhyayana, 36. 103.
65. Tarkarahasyadipikā, V. 49, (comm.) p. 159.
66. Sūtrakṛtāṅga, Śrūtaskandha II, Adhyayana 3,
67. Sūtrakṛtāṅga; Śrūtaskandha 2, Adhyayana 3; Navatattvaprakaranam, V. 6. (comm.) pp. 12-3; Lokaprakasa, Pt. I, 3rd Sarga, VV. 15 ff.
68. "Bhagnākṣatasāṁrohane", Śankara Misra, 1, Upaskāra, Chapter IV, Ahnika 2, Sūtra 5, B. 4, Vol. V. 1.
69. Biology, p. 18.
70. Ācārāṅga Sūtra, Book 1, Lecture I, Sixth Lesson, Sutra, 48, 69.; Sutrakṛtāṅga, Śrūtaskandha II, Adhyayana 3, Bhagavati 7.5.272; Sthānāṅga 3.1.129; 7.3.543, Uttarādhyayana Sūtra 36.1.10; Jivābhigama Sūtra 3.1.95, 1.33; Paṇṇavāṇī 1.58, 68; Tattvārtha Sūtra 2.32; Mūlācāra II 12. 43 45; Tarkarahasyadipika, V. 49 (Comm.) Gommaṭasāra, (Jiva), 83.

animal or plant.⁷¹ The simplest nigodajivas⁷² like viruses do not metabolize, move or grow, yet because they can reproduce⁷³ and undergo mutations, they are regarded as living.⁷⁴ As pointed out, one of the fundamental tenets of Biology is that “ all life comes only from living substances.”⁷⁵ It is stated in the Jaina Āgamas that worms or bugs or lice or vermins do come from the declining non-living fluids or sweat or dirt. But modern Biology has given convincing proof that they do come from eggs laid down by some flies attracted by the smell of the decaying dirt.

“ Bacteria do not arise by spontaneous generation by only from previously existing bacteria.”⁷⁶ “ The sub-microscopic filtrable viruses do not arise from non-viral material by spontaneous generation; the multiplication of viruses requires the presence of previously existing viruses.”⁷⁷

According to Jaina Biology; Plants have only asexual reproduction (Saṁmūrcchima),⁷⁸ while animals have both sexual and asexual reproductions (garbhavyutkrāntika and saṁmūrcchima).⁷⁹ The process of asexual reproduction may be simple as the splitting of one individual into two. The process of sexual reproduction in most animals, involves the

71. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3.

72. Bhagavatī, 12.2.443; 25.5.749; Gammaṭasāra, (Jiva) 191, 192, 193.

73. The Nigodas are the collections of infinite number of souls or (beings), making minutest groups, having common breathing in and out and experience of feeling, sensation, etc. They continue their evolution of life through the successive Jivaparyāyas, having longing for development, BHS. 12.2.443. In the common nigoda-body when one nigodajiva dies, then there takes place death of infinite nigoda Jivas, Gommaṭasāra, 193. “ Jatthekka marai Jivo, tattha du maraṇam have aṇamtaṇam //

74. Ibid., 193.

75. Biology, p. 18. Ācārāṅga Sūtra Book I, Lecture I, Sixth Lesson, Sūtra 48, p 68. “ Se bemi-saṁtime tasāpāñā, tamjahā-āṁdayā poyayā jarāuā rasayā saṁseyayā saṁmūrcchima ubbhiyayā uvavāiya, esa saṁsareti pavuccai ” Sūtra (48).; Sūtrakṛtāṅga, Śrutasandha I, Adhyayana 7, Sūtra I “ Puḍhavi ya aÿū aganī ya vāū, taṇa-rukkha-biyā ya tasā ya pāñā I Je aṁdayā je ya jarāuā pāñā, saṁseyayā je rasayabhidhānā ” Sūtra, p. 153. See also Sūtra 7 (Saṁseya, etc.)

76. Biology, pp. 18-19.

77. Ibid., p. 19.

78. Sūtrakṛtāṅga, Śrutasandha 2, Adhyayana 3, Sūtra 43, p. 91. “ Cattāri biyakāyā.... aggabiyā, mūlabiyā, porabiyā khamḍhabiyā ”; very vague ideas are contained in the Brāhmaṇical works as to the sexual characters of plants (See Amarakoṣa, Vanasadhi-varga), Caraka, Kalpasthāna, Ch. V. But the Rājanighaṇṭu tells of a grotesque division into male, female and hermaphrodite, based on the slender or stout, the soft or hard, the long or short, the simple or mixed character of the stems and flowers. According the Kaṭhopaniṣad the sexual reproduction in higher plants and higher animals is quite similar (Paṭwardhan K.A. Upanisads and Modern Biology, p. 59, Popular Book Depot, Bombay, 1957.)

production of specialised eggs and sperm which unite to form the fertilized Zygote from which the new organisms develop.⁸⁰

Adaptation :⁸¹

The Ability of a plant or animal to adapt to its environment is the characteristic which enables it to survive the exigencies of a changing world. Each particular species of plant or animal can become adapted by seeking out an environment to which it is suited to make it better fitted to its present surroundings. According to modern Biology, ' It is obvious that a single plant or animal cannot adapt to all the conceivable kinds of environment, hence there will be certain areas where it cannot survive or some areas where it can survive.'⁸²

Many factors may limit the distribution of a species, such as, habitat, earth, water, air, light, temperature, food, predators, competitors, parasites, etc.

The analyses of the types of plants⁸³ and animals⁸⁴ and their habitats,⁸⁵ etc. as recorded in the Jaina Āgamas shows that the types of plants, such as, trees,⁸⁶ shrubs⁸⁷ herbs,⁸⁸ creepers,⁸⁹ grasses,⁹⁰ etc. were distri-

79. Ācārāṅga Sūtra. Book 1, Lecture 1, Sixth Lesson, Sūtra 48, p. 69.; Sūtrakṛtāṅga Śrutasandha, II, Adhyayana 3; Sthānāṅga 2, 3. 1. 129; Bhagavatī, 7. 5. 282; Uttarādhyayana Sūtra, 36.170; Jivābhigama 3.1.96; Paññavanā 1.58; Tattvārthaśūtra, 2.32; Mūlācāra II, 1.24.3-45; Tarkarabhaśyadipikā (comm.) V. 49; Gommaṭasāra (Jiva), 83.

80. "Ithie purisassa ya Karmakadāe jōne ettha nām mehuṇavattiye (va) nāmām samjōge samuppajjai, te duhato VI siñehām sañcīnāmī... tattha, nām jivā itthittāe purisattāe napuṁsagattāe viuṭṭāmī /". Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3, Sūtra, 56, p 98.; See also Biology, p. 418.

81. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3; Bhagavatī Sūtra 7.3.27; Paññavanā Sūtra, Sthānapadam; Jivābhigama Sūtra, 1.24-36; Tarkarabhaśyadipikā, V. 49, (Jainamatam), Tīkā by Guṇaratna.

82. Biology, p. 20.

83. See Uttarādhyayana Sūtra, 36 VV. 94-104 for all types of plants; Paññavanā Sutta, Vanaśpatikāya jivapraññapanā 5, Sūtras, 35-54, pp. 16-27.

84. Uttarādhyayana Sūtra, 36, VV. 126-155. for all types of animals. Paññavanā I, Sūtras 56-138, pp. 21.35

85. Paññavanā Sutta 2, Sthānapadam, Sūtras 148-176; pp. 46-55.

86. Bhagavatī Sūtra, 22.2.692; 22.3.692; 22.4.692; 23.1.693; 23.3.693; 23.4.693; 23.5.693; etc.

87. Uttarādhyayana Sūtra 36. 94-104, Gulma, similar to the class Guccha, e.g. Vṛṇraka (Solamum Melongena) but brings forth twigs or stems, instead of stalks, e. g. Navamālikā (Jasminum Sambac), Kanavīra, etc.

88. Bhagavatī 21.7.691.

89. Ibid., 21.5.691; 21.6.691; 23.1.693; 23.4.693.

90. Ibid., 21.5.691; 21.6. ; 11.9.427; 12.8.459; 22.4.692.

buted over different regions of India where they could grow and adapt to their suitable environment to survive the exigencies of a changing world. The classification of animals by the Jainācārya into sthalacara (terrestrial), Jalacara (aquatic) and Khecara (aerial)⁹¹ beings, etc. throws light upon their habitat and ecology to which they could grow and adapt and make themselves better fitted in their survival.

The study of life of beings was made by the Jainācāryas in relation to environment, so climatic conditions have been described by them under the term 'Rtu'.⁹² It has been sub-divided into prāvṛt or varṣā (Rainy season = Śrāvaṇādi or Aśayujādih), Sārad (Mārgaśīrṣādhiḥ = Autumn), Hemanta (Māghādih = Winter), Vasanta (Caitrādih = Spring) and Griṣma (Jyeṣṭhādih = Summer).⁹³ The study of life in relation to environment probably began from the Vedic period⁹⁴ and climatic conditions were similarly treated under the same term 'Rtu' (Season) which was first sub-divided into three seasons, viz. Vasanta (Spring), Griṣma (Summer) and Śārad (Autumn).⁹⁵ Rtu has also been sub-divided into five seasons, viz. Vasanta, Griṣma, Varṣā, Sārad and Hemantaśiśira⁹⁶ or sometimes into six seasons⁹⁷ by separating Hemanta and Śiśira.

91. Bhagavatī 7.5.28?; Uttarādhyayaṇa Sūtra, 36.171; Jivabhigama Sūtra, 1.34.

92. Bhagavatī, 7.3.275; 9.33.383.

93. Bhagavatī 9.33.383.

94. Rgveda X. 9.6; Atharvaveda, VIII, 9.1.15; XIII, 1.18.

95. "Vasanto aśvāśidajyāṁ griṣma idhmaḥ śaraddhavi." Ibid.

96. "Śārade tva hemantaya vasantayā griṣmayā.." Ṛtava pañca, Ibid , XIII, 1.18. etc. "Varṣāṇi....1" Atharvaveda, VIII, 2.22; VIII. 9.15.

97. "Griṣmo hemantāḥ śiśira vasantāḥ śāradāḥ vaśāḥ" Atharvaveda VI, 55, 2, XII, 1.36; V. 1.5.2, 6.3, 2.6, etc.; "Griṣmāsti bhūme varṣāṇi śāradhemantāḥ śiśiro Vasantāḥ, Ibid , XII, 1.36. "Tubhyamityāha ṣaḍvā ṛtavāḥ ḥtuṣvēva 1". Taittiriyāśamhitā, V. 1.5.2; "Ṣaḍvā ṛtavāḥ" 1, Ibid , V. 1.5.7.3; "Ṣaḍvā ṛtavāḥ saṁvatsarāḥ" Ibid , V. 2.6.1, etc.

Third Section

Cells and Tissues

It appears from the study of the organization of bodies of plants and animals, from the finest plants to higher plants and from the finest earth quadrates to man as revealed in the Jaina Āgamas that the bodies of all plants and animals are composed of cells¹ and tissues.² But there is found no clear analytical study of cells and tissues of plants and animals in Jaina Biology as they are treated in modern Biology. New cells can come into being only by division of previously existing cells.³ According to modern Biology, "the cell is the fundamental unit of both function and structure—the fundamental unit that shows all the characteristics of living things."⁴

Cells :

In the simplest plants and animals all of the Vital force (paryāpti) is found within a single celled body, e.g. worm (Kṛmi)⁵ like a protozoa. These organisms may be considered to be unicellular⁶ with bodies not divided into cells. Earth quadrates,⁷ plant bacteria⁸ and two-sensed worms,⁹ etc., come under this unicellular category. They may have a

1. Abbuya (?). Tandulaveyāliya, 2, p. 6.

It is also suggestive from the reference to lakhs of pores in the skin of the body. that there are cells in the body of man and other vertebrates, *Ibid.*, 2, p. 6.

2. Peśi (?). Tandulaveyāliya, 2, p. 6.

Peśi (tissue) is made of arbudas (cells).

3. A single fertilized egg (kalala) develops gradually into a many-celled or five-celled embryo (PancaPiṇḍas) by the process of cleavage, indicating that the egg cell splits or divides. Out of five piṇḍas arms, legs and head come into being.; Tandilaveyāliya, 2, p. 6.

4. Biology, p. 35.

5. Uttarādhyayana Sūtra, 36.128.

6. Finest earth quadrates, plant bacteria and worms are the examples of unicellular beings.

7. "Puḍhavi ya āū aganī ya vāū" .. I

Sūtrakṛtāṅga, Śrutasandha I, Adhyayaṇa 7, Sūtra 1

Bhagavatī Sūtra 31.1.844; Uttarādhyayana Sūtra 36.

Paṇṇavana, Ekendriyajivapāṇṇavanā, 19, p. 122.

Gommaṭasāra (Jiva). V. 201.

8. Sūkṣma vanaspati (Subtile plant) of one class may be identical with bacteria of modern Biology. See Uttarādhyayana, 36.92.

Paṇṇavanā, Vanaspatikāyajivaprajñāpanā 35.

9. Uttarādhyayana Sūtra, 36.128.

high degree of specialization of form and function within the single cell and the cell may be quite large or small.

Modern Biology explains that “a single cell, if placed in the proper environment, will grow and eventually be divided to form two cells.”¹⁰

The cells of different plants and animals and of different organs within a single plant or animal as found in Jaina Biology appear to be a bewildering variety of sizes, shapes, colours, and internal structures, etc. as the sizes, etc. of their bodies¹¹ indicate, but all have certain features in common. All nutrients (rasa or sīneha)¹² entering the cell and all waste products. (khala)¹³ leaving it must pass through some membrane—a living, functional part of the cell, extremely important in regulating its contents. According to modern biology¹⁴ this membrane is called plasma membrane which regulates the contents of the cell.

The statement in the Jaina Āgamas that “the matr-āṅgas (mother's limbs) received and possessed by the child are his flesh, blood and brain and the pitṛ-āṅgas are his bone, marrow, hair, beard and hair on the body”¹⁵ suggests that each cell of the body of the child contains nucleus, “a small spherical or oval body usually,”¹⁶ as explained by modern Biology,—an important centre of control which contains the hereditary factors (genes) responsible for the traits of the organism and directs many aspects of cellular activity.

Energy (Virya)¹⁷:

Energy is the capacity to do work and to produce a change in matter or physical body.¹⁸ It is suggestive from the statement, “Deha-

10. Biology, p. 35.

11. Tesim puḍhavijoṇiyāṇam rukkhāṇam sarirā nānavaṇṇā nānāgāmīdhā nānārasā nānāphāsā nānāsāmītāṇasāmīhiya nānāvihasaīrā puggalavīvvitā 1”.
Sūtrakṛtāṅga, Śrutasandha II; Adhyayana 3, Sūtra 55.

12. Navatattvaprakaraṇām, V. 6, pp. 12, 13.; Lokaprakāśa, Pt. I, 3rd Sarga, VV. 15 ff.; Bhāṣṭaṅgrahaṇī, 36³, p. 130.

13. Sūtrakṛtāṅga II, 3. 55.

14. Navatattvaprakaraṇām, V. 6, pp. 12, 13.; Lokaprakāśa, Pt. I, 3rd Sarga, VV. 15 ff.; Bhāṣṭaṅgrahaṇī, 36³, p. 130,

15. Biology, p. 36.

16. “Tao māyāmīgā paṇṇattā, tamjāhā-māmīse sōṇie matthulūmīge 1” Tao piuyaṁgā paṇṇattā, tamjāhā- aṭṭhi aīṭhīmīmījā kesamāmīsuromāṇahe /”—Bhagavatī Sūtra, 1 7.61.; Tandulaveyāliya, Sūtra, 6, p. 10.

17. Biology, p. 36.

18. “Pratiniyataviśīṣṭāśariraraśaviryasniḍghatvarūkṣatva.... 1” Tarkarahasyādīpikā, Jain-mataām, V. 49 (Tīkā),, Guṇaratna, p. 159.

19. Ibid.

paryāpti brings about the assimilation and transformation of rasibhūta-māhāram (molecules of nutrients) into chyle (rasa), blood, flesh, fat, bone, marrow, semen²⁰ etc. of man and into the forms of five sense-organs ear, eye, nose, tongue, skin and bone, marrow, hair, beard, hair on the body (roma) and nail (nakha)²¹ of the embryonic growing child that the activites of paryāpti provide the energy for the growth and development of the organic system and cells may be thought of as energy transducers that convert the chemieal energy and food-stuff into the various forms²² of energy required for their activities. According to modern Biology, "Such energy transformations are the most fundamental processes of living cells."²³ "Energy may take the form of heat, light, motion, electricity and chemical energy, etc."²⁴ It is derived ultimately from the sunlight and stored in the molecules of food²⁵ as the chemical energy of the bonds connecting its constituent atoms. Modern Biology explains that "this chemical energy is a kind of potential energy (radianc energy) that may be thought of as the movement of photons or light quanta."²⁶ "All forms of energy are at least partially interconvertible and living organisms are constantly transforming one kind of energy into another."²⁷

Exchanges of Material Between Environment and Cells

The statement on the assimilation of food-stuff taken by man and other vertebrates and its consequent transformation into chyle, blood, flesh, fat, bone, marrow, semen, etc.²⁸ and the absorption of dissolved food-stuff by plants through roots in the form of sap (siñeha)²⁹ from

20. Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
21. Bhagavatī Sūtra, 1.7.61.: "Āhāram āhārei tam ciñāi soimdiyattāe cakkhuriimdiyattāe ghāmimdiyattāe jibbhimdiyattāe phāsimdiyattāe atthimimjakesamañsuromanahattae", Tandulaveyāliya, Sūtra, 3, p. 7.
22. Chyle, blood, flesh, fat, bone, marrow, semen, etc., Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
23. Biology, p. 42.
24. Ibid.
25. "Vaikriyāhārakaudārikāingayogyam yathocitām / tam rasibhūtamahāram yaya śaktyā punarbhavi //", Lokaprakāśa, Pt. I, 3rd Sarga, V. 18.
Energy is stored in rasibhūtam āhāram (molecules of nutrients). Besides, in summer some plants remain green by absorbing energy from the sunlight and storing it in leaf, flowers and fruits, (Bhagavatī 7.3.275) and also root, shoot, joint bulb, trunk, seed, (Gommanṭasāra, 186 (Jiva)).
26. Biology, p. 42.
27. Ibid.
28. Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
29. Sūtrākṛtāṅga, Śrutasandha II, Adhyayana 3, Sūtra 5.

the earth and its transformation implies the suggestion that all nutrients (rasa or siñeha) must pass through some membrane which surrounds each cell to get in or out of the cell, otherwise there cannot be any growth and development in animal and plant life and organism.

According to modern Biology, "each cell is surrounded by a plasma membrane and waste products must pass through this membrane to get in or out of the cell."³⁰ Usually only dissolved substances can pass through the plasma membrane, but not all dissolved substances can penetrate into this membrane equally well."³¹

Diffusion of Molecules of Nutrients (Rasa)

In Jaina Biology the process of absorption and assimilation of molecules of food-stuff and its consequent transformation into chyle (rasa), blood (asṛg), etc.³² by the vital force (Paryāpti) of the organism indicates the diffusion of molecules of nutrients. Modern Biology explains two kinds of diffusion, viz. dialysis and osmosis.³³ In dialysis the diffusion (movement) of dissolved molecules of nutrients takes place through a semipermeable membrane from a region of higher concentration to one of lower concentration, brought about by their kinetic energy, while in osmosis the diffusion of solvent molecules occurs through a semi-permeable membrane.

According to Jaina Biology, the solvent molecules in living systems are almost always water (rasa or siñeha).³⁴ The process of absorption and assimilation of dissolved food-stuff by plants from the earth through their roots in the form of liquid substance and its drawing up to the leaves by the root pressure as a result of the activity of the nitrogen-producing bacteria existing in the auxiliary roots³⁵ and soil throws some light on the law of osmosis of plant life as explained in Botany or Biology. "In the fluid of every living cells are dissolved salt, sugars and other substances that give the fluid certain osmotic pressure."³⁶

30. Biology, p. 44.

31. Ibid.

32. Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.

33. Biology, p. 45.

34. See Bhagavati 1.7.61; Tandulaveyāliya 5, p. 9.; Navatattva prakaraṇam, pp. 6-9.; Lokaprakāśa, Pt. I, 3rd Sarga, V. 10.; Tarkarahasyadipikā, V. 49.; for rasa; see Sūtrakṛtāṅga II, 3.5. for siñeha.

35. "Mulā mūlajivaphudā puḍhavijivapāḍibaddhā tamhā ahāremti tamhā pariṇāmemti Kaṁdā kaṁdajivaphudā mūlajivapadibaddhā tamhā ahāremi, tamhā pariṇāmemti evam jāva biyā biyajivaphudā phalajivapāḍibaddhā tamhā ahāremti tamhā pariṇāmemti /", Bhagavati, 7.3.276.

36. Biology, p. 45.

“When a cell is placed in a fluid with the same osmotic pressure as its own, water does not enter or leave the cell (i. e. the cell neither swells nor shrinks.)”³⁷

Tissues (Peśis)³⁸ :

A tissue is a group or layer of similarly specialized cells. According to the histology, “each kind of tissue is composed of cells which have a characteristic size, shape and arrangement.”³⁹ “Tissues may consist of more than living cells; blood and connective tissue, for example, contain some non-living material between the cells.”⁴⁰

Animal Tissues :

According to Jaina histology, animal tissues may be classified into six groups, viz. epithelia (ajina⁴¹ = carma = skin tissue), connective (ṇhāruṇi),⁴² muscular (māṁsapeśi),⁴³ blood (sōṇita⁴⁴ or aśg)⁴⁵, nervous (dhamaṇi and śirā)⁴⁶ and reproductive (Śukra and oja = Sperm and egg ova),⁴⁷ as they are found in modern Biology.⁴⁸

Epithelial Tissues :

Epithelial tissues have not been discussed by the Jainācāryas in details. But it is suggestive from the reference to the skin of animal⁴⁹ and lakhs of pores (romakūpa)⁵⁰ in the skin of the body of man that epithelial tissues are composed of cells which form a continuous layer or sheet covering the body surface or living cavities within the body. They may have one or more of the following functions, viz. protection, absorption, secretion and sensation (of touch). The epithelia of the

37. Ibid.

38. “Abbuyā jāyac pesī, pesīo ya ghanām bhave /” Tandulaveyāliya, Sūtra 2, p. 6.

39. Biology, p. 46.

40. Ibid.

41. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 2, Sūtra 18; Bhagavatī Sūtra 1.7.61; Tandulaveyāliya 3, p. 7.

42. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 2, Sūtra 18.

43. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 2, Sūtra 18; Tanduiaveyāliya 2, p. 6.

44. Ācārāṅga, Book II, 4; Sutrakṛtāṅga, Śrutasandha II, Adhyayana 2, Sūtra 18; Bhagavatī Sūtra, 1.7.6; Tandulaveyāliya, 2, p. 6.

45. Lokaprakāśa, Pt. I, 3rd Sarga, VV. 18-19.

46. Tandulaveyāliya Sūtra 2, p. 6.

47. “Duhao vi sineham saṁciṇāmī /” (Sūtra, 56); Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3; “Te jīvā maouyām piusukkām tam tādubhyām saṁsaṭṭham kalusan /” Bhagavatī Sūtra 1.7.61; Sūtrakṛtāṅga II.3.56.

48. Biology p. 46.

49. Sūtrakṛtāṅga, II, 2, 18; Bhagavatī Sūtra 1.7.61; Tandula Veyāliya, 3, p. 7.

50. Tandula Veyāliya, 2, p. 6.

body protect the underlying cells from the mechanical injury, from harmful chemicals and bacteria, and from drying.

It is inferrable from Jaina metabolism of organism to transform food-stuff taken by man into chyle (rasa)⁵¹ and to separate waste products (khala)⁵¹ that the epithelia lining the digestive tract, absorb food and water into the body as rasa (chyle). Other epithelia secrete a wide variety of substances as waste products (khala) in the form of sweat, etc. or for use elsewhere in the body.

As the body is entirely covered by epithelium (ajina or carma), so it is obvious that all tactile sensori stimuli must penetrate an epithelium to be received by the brain.

Modern Biology gives the following examples of epithelial tissues, viz. "the outer layer of the skin, the lining of the digestive tract, the lining of the windpipe and lungs and the lining of the kidney tubules."⁵²

Connective Tissues :

Connective tissue includes bone (asthi)⁵³ and cartilage,⁵⁴ tendons, ligaments, and fibrous connective tissue (ñhāruṇi).⁵⁵ It supports and holds together the other cells of the body. According to modern Biology, "the cells of these tissues characteristically secrete a large amount of non-living material called matrix and the nature and function of the particular connective tissue is determined largely by the nature of this intercellular matrix."⁵⁶

Fibrous connective tissue occurs throughout the body and holds skin to muscle, keeps glands in position and binds together many other structures.

Tendons and ligaments are specialized types of fibrous connective tissue. Modern Biology explains that "tendons are cable-like cords that connect muscles to each other or to bone, ligaments connect one bone to another."⁵⁷

The supporting skeleton of vertebrates is composed of cartilage or bone. Cartilage is the supporting skeleton in the embryonic stages of all vertebrates, when 2 arms, 2 legs and head come into being from

51. *Navatattvaprakaranam*, pp. 13-4 (Tikā); *Lokaprakāśa*, Pt. I, 3rd Sarga, VV. 15-21 ff.
Ibid.

52. Biology, p. 47.

53. *Sūtrakṛtāṅga* II. 2.18; *Bhagavatī*, 1.7.61; *Tandulaveyāliya*, pp. 8. 9.

54. That of ear, etc. See *Bhagavatī*, 1.7.61.

55. *Sūtrakṛtāṅga* II, 2. 18.

56. Biology, p. 47.

57. Biology, p. 48.

five piṇḍas⁵⁸ (or cells) by segmentation. But it is largely replaced in the adult by bone (asthi)⁵⁹ in all "but the skarks and rays",⁶⁰ according to modern Biology.

Bone is not solid structure as it is evidenced by the reference to marrow (asthimajjā).⁶¹ Most bones have a large cavity. The marrow cavity in the centre (cavity of majjā) which contains yellow marrow (majjā), "mostly fat", or red marrow, "the tissue in which red and certain white blood cells are made",⁶² as explained by modern Biology.

Muscular Tissue⁶³ :

Five hundred muscular tissues (peśis⁶⁴ or mānisapesis) in the body of the developing organisms are mentioned by the Jainācāryas. Muscular tissue may be classified into three distinct types of muscles in the human body, viz. skeletal, smooth and cardiac, although the Jaina texts have not mentioned them clearly. It is understandable from the reference to 500 muscular tissues⁶⁵ that skeletal muscle makes up the large muscle masses attached to the bones of the body. Out of the rest muscles some may be found as smooth muscle in the walls of the digestive tract and certain other internal organ and some as cardiac muscle in the walls of the heart (Hiyaya).⁶⁶

The movements of most animals result from the function of muscle cells (or tissues collectively) which perform mechanical work by contracting and getting shorter and thicker.

Blood Tissue (Śoṇita)⁶⁷ :

Blood tissue has been mentioned by the Jainācāryas as śoṇita or asṛg⁶⁸, but it has not been analytically explained by them like the modern Biologists. It is presummable from its redness in colour, its liquidness in character and the yellows marrow of the bone that it includes red (and white) cells and the liquid, non-cellular part of the blood, the plasma as they have been found by the Biologists. "Many

58. Tandulaveyāliya, 2, p. 6.

59. Bhagavati Sūtra 1.7.61; Tandulaveyāliya, 2, p. 6.

60. Biology, p. 48.

61. Bhagavati Sūtra, 1.7.61; Tandulaveyāliya, 2, p. 6.

62. Biology, p. 48.

63. Tandulaveyāliya, 2, p. 6.

64. Ibid.

65. Ibid.

66. Sūtrakṛtāṅga II, 2. 18.

67. Ācārāṅga, Book II, 4; Sutrakṛtāṅga, II 2, 18; Bhagavati 1.7.61; Tandulaveyaliya, 2, p. 61.

68. Lokaprakāśa, Pt. I, 3rd Sarga, VV. 18-19.

Biologists classify blood with the connective tissues because they originate from similar cells.”⁶⁹

Nervous Tissue (Dhamanis and Śirās):

According to Jaina Biology, there are stated to be nine dhamanis (arteries) and seven hundred veins (śirās) in the human body.⁷⁰ The Śuśruta⁷¹ and the Caraka⁷² also deal with the nervous tissue in detail. Nerve tissue integrates the activities of all the parts of the body.

It is suggestive from the functions of five sense-organs and the brain⁷³ of man that the nervous system is composed of brain, spinal cord and nerve trunks and it connects receptors with effectors and conduct impulses from one to the other.⁷⁴ According to modern Biology, “Nervous tissue is made of cells, called neurons, specialized for conducting impulses. Each neuron has an enlarged structure, the cell body, which contains the nucleus, and two or more nerve fibers extending from the cell body. The nerve fibers are made of cytoplasm and are covered by a plasma membrane.”⁷⁵

Reproductive Tissue :

Reproductive tissue is composed of cells modified to produce offspring-egg cells in females (ojas)⁷⁶ and sperm cells in males (śukra).⁷⁷ Human reproduction in common with that of most animals is accomplished gametes⁷⁸ – ova or egg cells (ojas) produced by the female and sperm cells (śukra) produced by the male.⁷⁹

Modern Biology explains that “egg cells are usually spherical or oval and non-motile.”⁸⁰

69. Biology, p. 49.

70. Tandulaveyāliya 2, p. 6.

There are न्हारा स्नायुस in the body of man and other vertebrates.

71. Sapta Śirāśatāni bhavanti... सुश्रुता, Śarirasthāna, Chapter VII, VIII, IX.

72. Carakasāṁhitā ... “Ojasah karmāṇi, śirā-dhamanī-srotasāṁ niruktih”, pp. 589-90, Vol. II.

73. Bhagavati Sūtra 1.7.61 (matthulūmge)

74. The muscles and gland of an animal are collectively called effectors, while the eyes, ears and other sense-organs are known as the receptors.

See Bhagavati 16.1.566 and prajñāpanā, Indriyanada for the function of sense-organs. See Biology, p. 353. for nervous system.

75. Biology, p. 49.

76. Sūtrakṛtāṅga, Śrutasandha II Adhyayana 3, Sūtra 56; Bhagavati, 1.7.61; Tandulaveyāliya, 2, 1-2, p. 6.

77. Ibid.

78. “Ithie purisassa ya kammakadāe jōne ettha नाम mehuṇavattiyāe... नामाम सम्जोगे samuopajjai, duhao vi siñehām सम्चिनामि... 1”, etc. Sūtrakṛtāṅga II, Adhyayana 3, Sūtra 56.

79. Ibid.

80. Biology p. 49.

In the Jaina Āgamas⁸¹ it is stated that the developing organism in the mother's womb at first feed on the ojas (i. e. yolk) of the mother and the śukra-semen (i. e. sperm cells) of the father or both combined into an unclean, foul substance from the time of fertilization until they are able to obtain food from the mother's body through the Putrajivara-saharaṇī (umbilical cord).⁸² This Jaina view is corroborated by the Nyāya Kandalī⁸³ and modern Biology also which explains that "The cytoplasm of the eggs of most animals, but not of the higher mammals, contains a large amount of yolk which serves as food for the developing organism from the time of fertilization until it is able to obtain food in some other way."⁸⁴

Plant Tissues :

It appears from the study of asexual reproduction (sammūrcchima) of plants from seeds, roots, knots and stems,⁸⁵ evolutionary trends in the plant kingdom from algae to angiosperm and organization of higher plants into roots, bulb, stem, bark, twigs or branches, leaves, flowers, fruits and seeds⁸⁶ that the cells of higher plants are also organized and differentiated into tissues. In Jaina histology four main types of tissues may be recognized, viz. meristematic, protective, fundamental and conductive as they are found in modern Biology.⁸⁷

Meristematic Tissue :

An embryonic plant begins development composed entirely of meristem, when the seed becomes transformed into a nucleus.⁸⁸

As it develops, most of the meristem becomes differentiated into

81. Sūtrakṛtāṅga, II, 3.5^a; Bhagavatī 1.7.61; Tandulaveyāliya Sūtra, 1, p. 6.
"Imo khalu jivo ammāpiusamāyoge māyuyāṁ piusukkāṁ tam tadubbayasamṣaṭṭhami
Kalusāṁ Kibbisāṁ tappaḍhamayāē. āhāram āhārittā gābt hattāē vakkamai /"
Tandulaveyāliya 1, p. 6.
82. Bhagavatī 1.7.61; Tandulaveyāliya 4, p. 8.
83. Samutpannapākajaiḥ kalalārambhakaparamāṇubhiḥ. piūḥ śukramātūḥ śonitām
tayoh̄ saṇipātānantaṁ jaṭharānalasambandhāt śukraśoṇitarambhakeṣu para-
māṇuṣu.. kalalaśāriṭopatiḥ etc. Śridhara, N. Kandalī, Pṛthivinirūpaṇām.
84. Biology, pp. 4⁴-51.
85. "Aṅgatāyā mūlābiyā porabiyā khaṇḍhabiyā /" Sūtrakṛtāṅga, II, 3.45, p. 91.
"Mūlagaṇa pirebiṇā kāmādā taha Khaṇḍhabijabijaruha Samuccchima ya bhaṇiyā
patteyānāṁtakāyā ya /" Gommaṭasāra, (Jiv. kānda) 18.
86. Aggābiya : Sūtrakṛtāṅga, II, 3.45.
87. Rukkhesu mūlattāē kāmādattāē khaṇḍhattāē tayattāē sālātāē pīvālattāē pattattāē
pupphattāē phalattāē biyattāē viuṭṭamti /" Sūtrakṛtāṅga, II, 3.47: Gommaṭasāra, 7
(Jiva) 188.
88. Biology, p. 51.
89. Gommaṭasāra (Jivakānda), vv. 187-8.

other tissues, root, etc.⁹⁰ That is to say, host individual plants in the beginning of their growth are non-host individual for an antar-muhūrta.⁹¹ They become host until they are so developed that the sinews and nerve appear on them, when they again become non-host individual.⁹²

The plants in which sinews, links, joints are unexposed or which break clean, which have no threads inside (ahirupa)⁹³ and which can grow from pieces are host bodies, while those that are reverse of these are individual (non-host).⁹⁴

This Jaina view on the meristematic tissue is indirectly supported by modern Biology which explains that meristematic tissues are found in the rapidly growing parts of the plant—the tips of the roots and stems, and in the cambium. The meristem in the tips of roots and stems called apical meristem is responsible for the increase in length of roots and stems and the meristem in the cambium called lateral meristem, makes possible the increase in diameter of stems and roots.”⁹⁵

“The meristematic tissues are made of small, thin walled cells with large nuclei. They are rich in protoplasm and have few or no vacuoles. Their chief function is to grow, divide and differentiate into all the other types of tissue.”⁹⁶

Protective Tissues (Tvac)⁹⁷ :

They consist of cells with thick walls⁹⁸ to protect the underlying thin walled cells from drying out and from mechanical abrasions. According to modern Biology, “the epidermis of leaves and the cork layers of stems and roots are examples of protective tissues. They prevent loss of surfaces, increase the absorption surface for the intake of water and dissolved minerals from the soil and prevents the entrance of water into the cork cells.”¹⁰⁰

90. Sūtrakṛtāṅga, II, 3.47; Gommaṭasāra. (Jiva), v. 188.

91. Gommaṭasāra (Jiva), p. 117 (comm.)

92. Ibid.

93. Paṇḍavanā, Vanaspatikāyājivapāṇḍavanā, 54-84; “Gūḍhasirasāṁdhipavvāṁ samabhāṁgamahiruyāṁ ca cinnāruhāṁ / Sāhāraṇāṁ sarīrāṁ tavvibāriyāṁ ca patteyāṁ //” Gommaṭasāra (Jiva), 18; Jivavicāra, 12.

94. Ibid.

95. Biology p. 51.

96. Bio'ogy. p. '1.

97. “Tvac”, Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 7.
“Chāli”, Gommaṭasāra, (Jivakāṇḍa), 18, 189.

98. Bije joniḥbhūde jivo caṅkamadi so va aṇṇo vā / Jevi ya mūlādiyā te patteyā paḍhāmadāe / Gommaṭasāra, (Jiva), V. 190.

99. Biology. p, 51.

100. Biology, p. 51.

Fundamental Tissues :

They make up the great mass of the plant body, including soft parts of the leaf, pith and cortex of stems and roots, and the soft parts of flowers and fruits.¹⁰¹ Their chief functions are the production and storage of food¹⁰² as explained by modern Biology¹⁰³ which states that “ the simplest of fundamental tissues, parenchyma, consists of cells with a thin wall and a large vacuole.”¹⁰⁴

Conductive Tissues :

It is stated by the Jainācāryas that host individual plants in the beginning of their growth are non-host individual for an autarmuhūrta. Then they become host until they are so developed that the sinews and nerves appear on them,¹⁰⁵ when they again become non-host individual.

This statement of the Jaina works implies the suggestion about the connective tissues of plants that there are two types of conductive tissue in plants, as explained by modern Biology, viz. xylem, which conducts water and dissolved salts and phloem, which conducts dissolved nutrients, such as, glucose.¹⁰⁶ It is suggestive that Guḍhaśirā and ahiruyam of plants¹⁰⁷ as explained in Jaina histology may be compared with xylem and phloem of plants of modern Biology.¹⁰⁸

Organ Systems :

According to Jaina Biology, the bodies of single – celled animals (e. g. earth quadrates¹⁰⁹ or two sensed animal – kṛmi (worm¹¹⁰) which may be identical with the protozoa of the Lower Invertebrate) and subtle plants (sūkṣma vanaśpati¹¹¹) are not organized into tissues and organs;

101. Sūtrakṛtāṅga II, 3.47; Gommaṭasāra (Jiva), v. 188.

102. Sūtrakṛtāṅga, II, 3.45; Gommaṭasāra, (Jiva), V. 185.

103. Biology, p. 52.

104. Ibid.

105. “ Guḍhacirāgam pattaṁ sacchirām jaṁ ca hoti nicchirām / jaṁ pi ya paṇaṭha-samdhīm aṇāṁtajivam viyāṇāhi ”, Paṇṇavāna, vānaśpatikāyajiva-Paṇṇavāna, 54.85
“ Guḍhasirasamdhīpavvām samabhamgamahiruham (ragam) ca chicharuhām sādhāraṇām sarirām, tattvivariyam tu patteyām ”, Jivavicāra 12.

“ Guḍhasirasamdhīpavvām samabhamgamahiruham ca chinnaruham / Sābāraṇāmarirām tattvibariyam ca patteyām //”, Gommaṭasāra (Jiva), 187, p. 116.

106. Biology, p. 52.

107. Paṇṇavāna Vanaspatikāyajivapaṇṇavāna 54. 84; Jivavicāra, 12; Gommaṭasāra (Jiva), v. 187.

108. Biology, p. 52.

109. Gommaṭasāra (Jivakānda), v. 201, p. 122.

110. “ Kīmiṇo somaṅgala.... / ”, etc. Uttarādhyayana Sūtra, 36.178.

111. Uttarādhyayana Sūtra 36.92; Bhagavatī Sūtra, 7.3.276; Gommaṭasāra (Jivakānda) p. 122.

all the life functions are carried on by the one cell,¹¹² as it is evidenced in the case of single-celled animals and plants of modern Biology.¹¹³ The bodily figures of the earth quadrates (i. e. earth, water, fire, and air-bacteria) are respectively speaking, (circular) like masur grain (lentil), (round like) a drop of water (i. e. cylindrical like), a bundle of needles (and oblong like) a flag. The bodies of plants and mobile bacteria are of various sorts.¹¹⁴

Nigodásarīra (body of Nigodajīva = Virus or micro-organism) which is the abode of infinite bacteria or viruses also is not organized into tissues and organs. The common differentia of these common (group) bacteria is said to be common food and common respiration.¹¹⁵ In that (common body) when one bacteria dies, there takes place the death of infinite bacteria (with it), (while) when one is born, there occurs the birth of infinite bacteria there.¹¹⁶ That is to say, a Nigoda body continues to exist, while every instant infinite bacteria in it die and new ones take birth.¹¹⁷

In more complex organisms a division of labour has occurred and special systems have evolved to perform each of the principal life functions. In man and other Vertebrates, for example, the circulatory system¹¹⁸ is made of organs - heart (hiyaya¹¹⁹), arteries (dhamanis¹¹⁹) veins (śirās¹²⁰), the heart tissue - cardiac muscle¹²¹, fibrous connective tissue and nerves (ṇhārunī)¹²², etc. and each type of tissue is composed of millions of individual cells as indicated by millions of pores¹²³ in the epithelial tissue (carma).

112. Worm (Kṛmi) does so, Uttarādhyayana 36.92.

113. Biology, p. 53.

114. "Masurāmvubimduśūkalābādhayasāṇīho have deho / puḍhavi ādicauphamā tarutasakāyā aneyavihā // " Gammaṭasāra, v. 201, p. 122.

115. Sāhāraṇamāhāro sāhāraṇamāṇapāṇagahaṇam ca /
Sāhāraṇajivāṇam sāhāraṇalakkhaṇam bhaṇiyām //, Ibid., v. 192.

116. Jatthekka marai jīvo tattho du maraṇam have aṇanītāṇam /
Vakkamai jattha ekko vakkamāṇam tatthāṇamāṇam // " Ibid., v. 193.

117. Ibid. (Comm.)

118. Sūtrakṛtāṅga, Śrutasandha II, Adhayayana 2; (Śoṇita, Hiyaya), Sūtra, 18 (ṇhārunī); Tandulaveyāliya 2, p. 6 (śoṇita, dhammaṇi, śirā)

119. Sūtrakṛtāṅga, II, 2.18.

120. Tandulaveyāliya 2, p. 6

121. Ibid. It is suggestive that out of 500 muscle tissues there must be some cardiac muscles.

122. Sūtrakṛtāṅga, II, 2.18; (ṇhārunī); Tandulaveyāliya 2, p. 6.

123. Tandulaveyāliya 2, p. 6.

It is suggested by lakhs of rōṇakūpas (pores) in the skin as mentioned by Tandulaveyāliya

In man and other vertebrates eleven organ systems can be distinguished, viz. (1) the circulatory system¹²⁴, which transports materials around the body, (2) the respiratory system¹²⁵, which provides a means for ucchvāsavāyu (i. e. oxygen ?) to enter and nihvāsavāyu (carbon – dioxide ?) to leave the blood, as explained in modern Biology¹²⁶, (3) the digestive system¹²⁷, which takes in food, breaks it up chemically into small molecules of nutrients (rasa)¹²⁸, (4) the excretory system¹²⁹, which eliminates the waste products (khala)¹³⁰ in course of metabolism, (5) the integumentary system¹³¹ which covers and protects the entire body, (6) the skeletal system¹³², which supports the body and provides for movement and locomotion, (7) the muscular system¹³³, which functions with the skeletal system in movement and locomotion, (8) the nerve system¹³⁴, which conducts impulses around the body and integrates the activities of the other systems, (9) the sense – organs¹³⁵, which receive stimuli from the outer world and from various regions of the body, (10) the endocrine system¹³⁶, which is an additional co-ordinator of the body functions, and (11) the reproductive system¹³⁷, which provides for the continuation of the species.

124. Sūtrakṛtāṅga II, 2.18; Bhagavatī Sūtra 1.7.61; Tandulaveyāliya 2, p. 6, pp. 8, 9.

125. Bhagavatī Sūtra, 1.7.61; Paññavānā, Ucchvāsapadām, 693-724, pp. 184-7; Navatattvaprakaraṇām, p. 12; Jīvavicāra, pp. 42-44.

126. Biology, p. 54.

127. Bhagavatī Sūtra, 1.7.61; Navatattvapratikaraṇām, v. 6; Lokaprakāśa, Pt. I, 3rd Sarga, vv. 15 ff; Gommaṭasāra (Jīva). VV. 118-19.

128. “Tatrasāhāraparyāptiriyayādāya nijocitām /
Pṛthakkhalarasatvenāhāram pariṇatām nayet//”, Lokaprakāśa, Pt.I, 3rd Sarga, v.17.
“Yayā śaktyā punarbhavī // (18)
Rasasāgmaṁsamedo asthimajjaśukrādīdhatunām /
Nayedyathāsambhavām sā dehaparyāptirucyate //”, Ibid., v. 19.

129. Bhagavatī Sūtra, 1.7.61; Tandulaveyāliya, p. 6; Lokaprakāśa, Pt. I, 3rd Sarga, v. 15.

130. Lokaprakāśa, Pt. I, 3rd Sarga, V. 17; Navatattvaprakaraṇām, v. 6.

131. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 2, Sūtra 18; Bhagavatī Sūtra 1.7.61; Tandulaveyāliya, pp. 8-9.

132. Ibid.

133. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 2, Sūtra 18; Bhagavatī 1.7.61; Tandulaveyāliya 2, p. 6.

134. Tandulu Veyāliya, 2, p. 6.

135. Bhagavatī Sūtra, 16.1.566; 2.4-99; 3.9.170; Tandula Veyāliya, V. 3, p. 7; Paññavānā, Indriyapadām, 19.

136. Sūtrakṛtāṅga, Śrutasandha, II, Adhyayana 2, Sūtra 18 (nārūṇī).

137. “Itthie purisassa ya kammakadē jōnie ettha nām mehuṇavattiyāc (va) nāmām saṁjoge samuppajjai, duhaovi sinehām saṁciṇāmī, tattha nām jīvā itthittāe purisattāe nāpūṁsagattāe viuttamī /”, Sūtrakṛtāṅga, II, 3.56, p. 98.

(Fourth Section)

Cellular Metabolism

Metabolism¹ is the chemical reactions of cells, which provide energy for their growth,² irritability,³ movement,⁴ maintenance and repair⁵ and reproduction⁶ of organisms, briefly stated that metabolism is the wear and tear. The Jainācāryas have thrown some light upon the cellular metabolism of animal organisms from the moment of their birth up to their death in the following manner that the food stuff, when taken in, is transformed into rasibhūtam āhāram (molecules of nutrient), and

1. Sūtrakṛtāṅga, Śrutaskandha II, Ādhyayana 3, Ahāranikṣepa Varṇau; Bhagavati sūtra, 1.7.61-3, 7.3.275-6; Paññavānā. Āhārapadām, Pajjattidāram, 2nd Uddeśaka, p. 406; Tandula Veyāliya, pp. 3-10; Navatattva Prakaraṇa by Dharmavijaya, V. 6, pp 12 ff; Lokaprakāśa, Pt. I, 3rd sarga, VV. 15-21; Gommaṭasāra (Jivakāṇḍa), chapter III, VV. 1:9-121; Mūlācāra II, VV. 12-14; Tarkarahasyadipikā on Śaddarśana Samuccaya (Jainamataīm), V. 49 (Tīkā), Guṇaratna.
2. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtras 55-62; Bhagavati sūtra, 1.7.61-2, 7.3.276; Tandula Veyāliya, VV. 2-6: Tarkarahasyadipikā (Tīkā) on V. 49. “Yathedam manuṣyaśarīramanavarttam....Pratiniyatam vārdhate, tathedamapi vanaspatiśarīramāṇkurakisalaya.....viśeṣaiḥ pratiniyatam vārdhata iti 1”, p. 157. Ibid.
3. Bhagavati Sūtra, 3.9.170, 2.4.99; Paññavānā Sutta, Indriyapadām 15, Puṭṭhadāram, etc.; Tarkarahasyadipikā (Tīkā) on V. 49. “Tathā lajjālūprabhṛtinām hastādi-samoparśatpātrasāmkośadikā parispūṭā kriyopalabhyate”, Ibid. p. 158.
4. Acārāṅga Sūtra, Book I, 9.1.14; Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18, Sūtra 60; Sthānāṅga 2-4.100; Bhagavati Sūtra, 25 4.789; Uttarādhyayana Sūtra 36.68; Jivābhigama Sūtra, p. 12; Mūlācāra, Pt. I, 30 (226), p. 295; Tattvārtha Sūtra, 2.12.14; Tarkarahasyadipikā, V. 49 (Tīkā) “Svāpaprābodhasparśādi-hetukollāsasāmkośayorprasarpaṇādiviśiṣṭānekakriya”, p. 159.
5. “Yathā manuṣyaśarīram hastādicchinnam śuṣyati, tathā taruṣarīramapi pallavakusumādicchinnam viśeṣamupagacchaddṛṣṭam 1”. Tarkarahasyadipikā, Tīkā on Verse 49, p. 158; yathā, yathā manuṣyaśarīrasya tattadrogasāmparamkād ..vigālanādi, tathā vanaspatiśarīrasyāpi tathāvidharogodbhavātpuṣpa....pattanādi 1 Tathā, yathā manuṣyaśarīrasyāuśadhaprayogadvyddhihānikātābhagnasāmrahaṇāni, tathā vanaspatiśarīrasyāpi 1 Tathā, yathā manuṣyaśarīrasya rasāyanasneḥadyupayogadviśiṣṭākāntirāśalopacayādi, Tatahā Vanaspatiśarīrasyāpi Visiṣṭeṣṭānabhojalādisekādvisiṣṭārasaviryasnigdhatvādi 1”, — Tarkarahasyadipikā, Tīkā on V. 4 , pp. 158-9.
6. Sūtrakṛtāṅga. Śrutaskandha II, Adyayana 3; Bhagavati Sūtra, 7.5.282; Sthānāṅga, 3.1.129, 7.3.545; Uttarādhyayana Sūtra 36.170; Jivābhigama Sūtra 3.1.96, 1.33; Paññavānā Sutta, 1.5*, 68; Mūlācāra, Pt. II, 1.2.43-45; Tattvārtha Sūtra ch. II.32; Tarkarahasyadipikā, Tīkā on V. 49 ‘ Vanaspatayoh janmajarāmarāgaṛogādinām samuditānām sadbhāvat, Srivat 1 ”, p. 154, Ibid.

rasa (chyle) which in turn gets transformed by paryāpti (vital force), into different elements of organism, such as blood, flesh, fat, bone, marrow, semen,⁷ etc. in successive order.

According to Jaina Biology, the metabolic activities of animal, plant and bacteria cells are remarkably similar,⁸ despite the differences in the appearances. One of the matabolic difference between plants and animals is the ability of green plants⁹ to carry on photosynthesis, to trap the energy of sunlight and to use it to synthesize compounds, i. e. “to incorporate carbon dioxide molecules into organic compounds”,¹⁰ as it is suggested by the following statement. “In Summer season many usnayonikajivas and pudgalas get produced as plant-bodied beings (Vanaspatikāyikas) in certain numbers and they increase and decrease also in certain numbers and get reproduced, for this reason many plants having leaves, flowers and fruits, appear to be green and shining.”¹¹

This scientific suggestion on photosynthesis is supported by Modern Biology in this manner. “In this way plants synthesize carbo-hydrates and from them, proteins, fats and other substances. Bacteria and animal cells also have the ability to “fix” carbon dioxide, to incorporate carbon dioxide into a variety of organic compounds, but only green plants and a few bacteria have the ability to convert radiant energy to chemical energy to drive the process; animals and bacteria must get the energy for carbon dioxide fixation from energy-yielding processes.”¹²

Chemical Reactions

It appears from the activities of paryāpti (vital force)¹³ that a chemical reaction is a change¹⁴ involving the molecular structure of one or more substances; matter (pudgala) is changed from one substance,

7. Lokaprakāśa, Pt. I, 3rd Sarga, VV. 18-21; Navatattvaprakaraṇa, V. 6, pp. 12, 13, 14, 15, 16.
8. Śaddarśana – Samavuccaya with Guṇāratna’s commentary Tarkarahasyadīpikā “Bakulāsokacampakādyanekavidhavanaspatināmetāṇi śarīrāṇi na Jivavyāpāraman-tareṇa, manuṣy, śarīrasamānadharmabhāṇji bhavanti 1” p. 157 “Tathā yathā, manuṣya śarīram stanakṣṭravyāñjanau dananāñdyāhārābhya vahārādāhārakam 1”, p. 158. Ibid. “Tathā yatha manuṣyaśarīrasya rasāyanasunhādhyupayogādviśiṣṭa-kāntirasābalopacayādi, tathā vanaspatisarirasyāpi viśiṣṭeṣṭanabhojalādisekādviśiṣṭa-rasaviryasnidhātavādi 1”, Ibid. p. 159.
9. Bhagavati Sutra, 7.3.270.
10. Biology, p. 56.
11. Bhagavati Sūtra 7.3.275.
12. Biology, p. 56.
13. Lokaprakāśa, Pt. I, 3rd Sarga, vv. 15, etc.; Navatattvaprakaraṇam, v. 6; p. 12 etc.
14. “Pudgalāñcāhādisvarūpāñm khalarasādipariṇamane,” etc. Navatattvaprakaraṇa, (comm.) on v. 6, p. 13.

with its characteristic properties, to another with new properties¹⁵ and energy¹⁶ is released or absorbed, as is suggested by the statement that dehaparyāpti (the vital force of the body) brings about the change in rasibhūtam āhāram (molecules of nutrients) and transforms them into different elements of organism, such as, rasa (chyle), asṛg (blood), māṁsa (flesh), meda (fat), asthi (bone), majjā (marrow), śukra (semen), etc.¹⁷ in successive order by providing energy to change one substance, with its characteristic properties, to another with new properties. In this way a chemical reaction is brought about by paryāpti in the transformation and operation of sense-organs¹⁸ involving the molecular structure of one or more material substances (pudgalas).

This course of metabolism or chemical reaction from the molecules of nutrients (rasibhūtam āhāram) to chyle (rasa) up to semen (śukra), etc. is clearly explained in Caraka Dṛḍhavala Saṁhitā quoted by Aruṇadatta in his commentary on Vāgbhaṭa in the following manner: "The food stuff which goes down the gullet by the action of prāna vāyu (biomotor force) becomes mixed up first with a gelatinous mucus (pheṇibhūtam kapham) and then gets acidulated by the further chemical action of a digestive juice (Vidāhādamlatām gataḥ). Next samānavāyu drives down the chyme by means of the grahaṇinādi (oesophagus canal) to the pittāsaya (duodenum) and thence to the small intestines (āmapakkāśaya). The bile acts on the chyme and converts the latter into the chyle (rasa). This chyle contains in a decomposed and metamorphosed condition all the organic compounds, viz. tissue-producing earth-compounds, water-compounds, teja-compounds, vāyu-compounds and finer etheric constituents which serve as the vehicle of consciousness. The essence of chyle (sūkṣmabhāga) is driven by prāṇavāyu, from the small intestines first to the heart, thence to the liver (and the spleen); in the liver the colouring substance in the bile acts on the essence of chyle, especially on the teja-substance therein, and imparts

15. Ibid.

16. "Dravyanimittam hi samsarinām viryamupajāyate", Karmaprakṛti, vide Navatattvaprakaraṇa, p. 13.

17. "Tam rasibhūtamāhāram yaya śaktyā punarbhavi //
Rasasṛgmaṁsamedo asthimajjāśukrādīdhātutām /
Nayedyatħasambhavam sā dehaparyāptirucyate /"
Lokaprakāśa, Pt. I, 3rd Sarga, vv. 18-19; Navatattvaprakaraṇa, pp. 12, 13, 14, 15, 16.

18. "Dhātutvena carinatādāhāradīndriyocitā /
Ādāya pudgalāṁstāni yathāsthām pravidhāya ca //
Iṣṭe tadviṣayajñaptau yaya śaktyā śarīravān /
Paryāptih sendriyāvhanā darśita sarvadarśibhiḥ // " Lokaprakāśa, Pt. I, 3rd Sarga, vv. 20-21; See also Navatattvaprakaraṇa (comm.) on v. 6, pp. 12-16.

to it a red pigment, transforming it into blood; the grosser part of chyle (sthūlabhāga) proceeds along the Dhamanī (arteri), being driven by Vyāna vāyu (bio-motor force), all over the body. On the formation of blood the essence of chyle in the blood, acted on by Vāyu (bio-motor force) and māṁsāgni (the flesh forming metabolic heat) forms flesh-tissue (māṁsa). Of the flesh-tissue, thus formed, the grosser part goes to feed or replenish the flesh tissue all over the body. The finer essence of flesh in the blood in the chyle, acted on again by Vāyu (bio-motor current) and the fat-forming metabolic heat (Medo agni) in the menstruum of lymph (Kapaṁ samāśritya) receives viscosity and whiteness and produces the fatty tissue. This fat in the chyle (or blood) or rather the grosser part of it, replenishes the fatty tissue of the body, but the finer essence of fat in the flesh, in blood, in the chyle, acted on by Vāyu (bio-motor current) and the marrow-forming metabolic heat, in the menstruum of lymph (śleṣmanāvṛta) becomes hard (crystalline) and forms bone. The essence of the fat fills the hollow channels of the bones, and acted on again by the Vāyu (bio-motor current) and metabolic heat, gets transformed into marrow (majjā). The marrow is similarly transformed into the semen, which is conveyed down by means of a pair of dhammanis or ducts (dve śukravahe), lodged in its receptacles (śukradharā-Vṛṣaṇau) and discharged by means of another pair of ducts. The semen, or rather all elements in their finer essence, give off ojas, which returns to the heart, the receptacle of chyle and blood, and again floods the body and sustains the tissues, thus completing the wheel or self-returning circle of metabolism (Parivṛttistu cakravat)."¹⁹

19. “Ādaū ṣaḍraṣamāpannāṁ madhuribhūtāṁ kaphāṁ yātāṁ vidāhādaṁ laṁāṁ gataḥ / vāyuṇā samānākhyena grahanī na-hinīyate / ṣaṣṭhī pitt-dh rā nānā yā kalā parikirttī / āmapakkāśayāntahsthā grahanī sā abhidhīyate / agnyadhiṣṭhānamannasya grahanī matā / bhuktamāmāsaye ruddhā sā vīpacya nayatyadhaḥ. balavātyavalā tvannamāmameva vimuñcati /.... annasyapak्त्र pittantu pācakākhyāṁ pureritāṁ / doṣadhatumalādīnāmuṣṭyatre-yaśasanāṁ /.... tejorāsānāṁ sarveṣā an bujānāṁ yaducyate, pittomanā sarāgena raso raktatvān ṣeṭchāti / Vāyagnitejasā yuktaṁ raktāṁ māṁsatvamṛchchati / śleṣmānāṁ ca samāśritya māṁsām Vāyagnisāmyutāṁ sthiratāṁ prāpya śaukalyām ca medo dehe abhijāyate / pṛthivpagnyanitādīnāṁ sāṁghātāḥ śleṣmaṇāvṛtāḥ, kharatvāṁ prakarotyasya jāyate asthi tato nṛtāṁ / karoti tatra sauśiryumāsthnāṁ madhye samīraṇaḥ / medasā tāni pūryante sneho majjā tataḥ smṛtaḥ / taśmān-majjīnaśca yaḥ snehaḥ śukraṁ samjāyate tataḥ /” Vāgbhaṭa’s – Aṣṭāṅgahṛdaya-vyākhyā by Arīṇātta, Śarīrasthāna 3/62 Caraka-Dṛḍhivāla Samhitā quoted by Arūṇa in his commentary on Vāgbhaṭa, Vide Positive Sciences of the Ancient Hindus by Dr. B. N. seal, p. 207; Tathā Caravasāmhitāyāṁ Dṛḍhāhalo’ pyāha/ rasādraktāṁ tato māṁsām māṁsān edastālo, asthi ea / asthno majjā tat h śukraṁ Śukrādgarbhaḥ prasādajah // Vāgbhaṭa’s Aṣṭāṅgahṛdayavyākhyā by Arīmdatt, Śarīrasthāna, 3/62.

Respiration and Energy Relation

All of the phenomena of life growth, movement, irritability, reproduction and others require the expenditure of energy (Virya),²⁰ by the cells organism. Living cells must have chemical energy.

According to modern Biology, "all living cells obtain biologically, useful energy primarily by enzymic reactions in which electrons flow from one energy level to another."²¹

The Jainācāryas state that the vital force (Paryāpti) by which organisms inhale (breathe in) the particles of suitable respiratory air (Ucchvāsamārhamādāya dalam), (i. e. Oxygen), transforms it and exhales it (as carbon-dioxide) is called Ucchvāsaparyāpti.²²

Now the question arises what is the necessity of paryāpti in respiration, when body and respiration are brought about by deha-ucchvāsanāmakarmas (body-respiration producing karma).²³ The reply is that the transformation of matters received by the soul as body is brought about by dehanāmakarma (body-producing karma), while the completion of the started aṅga (body) is brought about by paryāpti (vital force).²⁴ This difference of dehanāma karma—from parvāpti karma is due to the difference of sādhya²⁵ (performance). Thus ucchvāsa—labdhi (faculty or energy of respiration) is brought about by dehanāmakarma, and its vyāpārṇam (manifestation or actually) takes place due to ucchvāsa—paryāpti (the vital force of respiration).²⁶

Even there being the faculty (labdhi=energy) of respiration, born of Ucchvāsanāmakarma, there should be ucchvāsaparyāpti to make it manifested (i. e. bring it into actuality).²⁷ As for example, there being the śakti (capacity) to cast the arrow, one does not become soldier, without the capacity of drawing the bow to make it a success.²⁸

This subtle reference to respiration and energy suggests that "for most organisms oxygen is the ultimate electron acceptor, oxygen reacts

20. "Pratiniyatavīśiṣṭaśarirarasavīyas igdhatvarūkṣvatva", Tarkarahasyadipika, Tīka on V. 9, p. 159.
21. Biology, p. 62.
22. "Yayocchvāsārhamādāya dalam pariṇamayya ca /
Tattayālambya muñcetsocchvāsaparyāptiru yate // " Lokaprakāśa, Pt. I, 3. d Sarga, V. 22; Nayatattvapratikriyānam, (comm.) on V. 6, pp. 12-16.
23. Ibid., V. 23; see also Navatattvapratikriyā (comm.) V. 6, pp. 12-16.
24. Ibid., V. 24; See also Navatattvapratikriyā (comm.) V. 6, pp. 12-16.
25. Ibid., V. 25.
26. Ibid., V. 26.
27. Ibid., V. 7.
28. Ibid., V. 28.

with the electrons and with hydrogen ions to form a molecule of water... ...Electrons are removed from a molecule of some food-stuff and transferred (by the action of a specific enzyme) to some primary acceptor.”²⁹

The Dynamic State of Paryāpti (Vital force)

.. Paryāpti (vital force) is in a constant state of flux as it provides energy in the metabolic process of organisms. The body³⁰ of a plant or animal appears to be changing as days and weeks go by. It may be inferred from this that the cells of the body, and the component molecules of the cells are equally changing. This view is supported by modern Biology which explains that “ protoplasm is in a constant state of flux. Labeled amino acids are rapidly incorporated into body proteins and labeled fatty acids are rapidly incorporated into fat deposits, even though there is no increase in the total amount of protein or fat. The proteins and fats of the body—even the substance of the bones—are constantly and rapidly being synthesized and broken down. In the adult the rates of synthesis and of degradation are essentially equal so that there is little or no change in the total mass of the body. Thus the distinction between “ machinery ” molecules and “ fuel ” molecules becomes less sharp, for some of the machinery molecules are constantly being broken down and used as fuel.”³¹

Special Types of Metabolism

In addition to the general metabolic activities Jaina Biology, throws some light upon special metabolic activities of certain animals and plants. Green plants³² can photosynthesize; certain bacteria³³ and animals³⁴ can

29. Biology, p. 62.

30. e. g. man and plant

“ Tathā, yathedam manusyaśāśramanavarataṁ bālakumārayuvādyavasthāviśeṣaiḥ pratiniyatāṁ vādhate, tathedamapi vanaspatisarīramāñkurakiśalayaśakhāpragā-khādibhirviśeṣaiḥ pratiniyatāṁ vādhata iti / ” Tarkarahasyadipikā p. 157.

“ Tathā, yathā manusyaśāśraso rasāyanasneḥādyupayogādvīśiḥ kāntirasābalopacayādi, tathā vanaspatisarīśayāpi viśiṣṭānabhojalādisēkādvīśiṣṭarasaviryapniog dhaṭvādi / ” Ibid., p. 159.

31. Biology, p. 76.

32. Bhagavatī Sūtra, 7.3.275-6.

33. “ Bādarasyodyotena sahitasya ” (one sensed-bacteria, earth-bacteria, water-bacteria and plant-bacteria emit cold light), karma grantha (6th), p. 186; Two-sensed worm (kṛmis-protozoa emits cold light) Uttarādhyayana Sūtra, 36.128; TS. II 24.

34. “ Aṇusīṇa payāsa rūvāṁ, jiaṅga mujjoae ihujjhoā, jai devuttara vikkia, joisa khajjoa māīva ”, 46, Karmagrantha I, p. 85; Nūpuraka (Annelida) TS. II. 24; Gaṇḍūpada (Crustaceans). Ibid.; Satapadī (Centipeds), Ibid.; Śaṅkha (Molluscs) Ibid.; Khadyota (Glow worm), Tarkarahasyadipika, p. 156.

“ Yathā rātrau khadyotakasya dehapaṇīmō/jīvaprayoganirvṛttasaktirāvīścakāsti / ” Ibid.

produce light. Certain plants produce wild variety of substance-flower pigments,³⁵ perfumes,³⁶ many types of drugs³⁷ and bacteria³⁸ and molds; certain animals can make deadly poisons³⁹ and also antibiotics⁴⁰ like the best chemists.

Bioluminescence

Although the glow worm (khadyota)⁴¹ is the most conspicuous light-emitting organism, a number of other animals and some bacteria also have this ability.

Luminescent animals appear to be found among the protozoa,⁴² annelids (nūpuraka),⁴³ crustaceans (gaṇḍūpada),⁴⁴ centipedes (ṣatapadī),⁴⁵ molluscs (Śankha),⁴⁶ etc. This scientific evidence of bioluminescēna is supported by modern Biology which states that the fire-fly and glow-worm are the most conspicuous light-emitting organism,⁴⁷ and " Luminescent animals are found among the protozoa, sponges, coelenterates, ctenophores, nemerteans, annelids, crustaceans, centipedes, millipedes, beetles, echinoderms, molluscs, hemichordates, tunicates and fishes. There appears no single evolutionary line of luminescent forms; the ability to emit light has appeared independently a number of times."⁴⁸

" It is sometimes difficult to establish the fact that an organism is itself luminescent in a number of instances, the light has been found to be emitted not by the organism but by bacteria. Several exotic East

35. Mañjisthā (Indian Madder), Bhagavatī Sūtra, 8.6.334.

36. Ketaki flower produces perfume, Bhagavatī Sūtra 16.6.582.

37. Hīngurukkha (Forula, Asaf tida). Bhagavatī 22.2.692; Haritage (Terminalia chefula), Ibid. 22.2.692; Bhallāya (Acajou; especially, acid quince for medicine), Ibid.; Asoga (the tree Jonesia Asoka), Ibid.; Arjuna (the Arjuna tree), Ibid. 22-3.692; Akkavordina (the plant Calotropis Gigantea for optic nerve), Ibid., 22-1.693; Bhaṅgī (Can abis sativa), Ibid., 23.5.69 ; Tulsi (Roly basil) Ibid., 21.8.69 .

38. Sūtrakṛtāṇa, II, 3.

39. Vṛścikā (Scorpion). Mañduka (frog), Uraga (snake), Bhagavatī, Sūtra, 8.7.376; Ahi (a class of snake), Ajagara (a class of snake). Ibid., 15.1.560.

40. Nakula (mangoose) Ibid., 8.3.12 ; 15.1.560.

41. Tarkarahasyadipika, Ṭikā on v. 49, p. 156; Sarvārthasiddhi, Ācārya Pūjyapāda, p. 9; Knrmagrantha I, v. 46.

42. Uttarādhyayana Sūtra 36.128; Tattvārtha Sūtra, II. 24.

43. Tattvārtha Sūtra, II. 24.

44. Ibid.

45. Ibid.

46. Ibid.

47. Biology, p. 77.

48. Ibid., p. 77.

Indian fish have light organs under their eyes in which live luminous bacteria. The light organ contains special long cylindrical cells, well supplied with blood vessels to supply the bacteria with adequate amounts of oxygen. The bacteria emit light continuously and the fish have a black membrane, like an eyelid, that can be drawn up over the light organ to turn off the light. No one knows how the bacteria to collect in the fish's light organ, as they must in each newly hatched fish.”⁴⁹

The light produced by luminescent organisms, glow-worm, etc. is entirely in the visible spectrum. Bioluminescence light may be called udyota⁵⁰ (i. e. “Cold light”),⁵¹ since very little heat is given off, as it is explained by modern Biology.⁵² “The production of light is an enzyme-controlled reaction, the details of which differ in different species. Bacteria and fungi produce light continuously if oxygen is available. Most luminecent animals give out flashes of light only when their luminescent organs are stimulated.”⁵²

49. Ibid., pp. 77-78.

50. Tattvarth Sūtra, v. 24; Sarvārthasādhi, v. 24, p. 296 (Udyotascandramāṇikhad-yotādiprabhavaḥ.) Prakāśah / ”,

51. Biology, p. 78.

52. Ibid., p. 79.

SECOND CHAPTER
THE WORLD OF LIFE: PLANTS
(First Section)

Biologic Inter-relationship

At first glance the world of living substances (Jivadravyas) as revealed in the Jaina works appears to be made up of a bewildering variety of plants and animals,¹ all quite different and each going its separate way at its own pace. A close study of them reveals, however, that all organisms, whether plant or animal, have the same basic needs for survival, the same problems of getting food² for energy, getting space to live,³ producing a new generation⁴ and so on. In solving their problems, plants and animals have evolved into a tremendous number of different forms,⁵ each adapted to live in some particular sort of environment.⁶ Each has become adapted not only to the physical environment—has acquired a tolerance to a certain range of moisture, wind, sun, temperature and so on—but also the biotic environment,⁷ all the plants and animals living in the same general region. Living organisms are inter-related in two main ways, evolutionary descent⁸ and ecologically.⁹ One

1. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, sūtras 48-62; Bhagavatī Sūtra, 33.1.844; 7.5..82 etc.; Uttarādhyayana Sūtra 36.68-202; Paññavānā Sutta, Jivapaññavānā 14-138; Jivābhigama Sūtra, 3.96; 1-33, 34; Gommaṭasāra (Jivakāṇḍa), 1.35.70, 71, 72, etc.

2. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, sūtras 40-62.

3. Ibid.

4. Ibid.

5. Uttarādhyayana Sūtra, 36.135. 144, 169, 178, 179, 186, 193, 202.

6. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3; Bhagavatī 7.5.2-2; Uttarādhyayana 36.171 ff; Jivābhigama 1.34, 35; Paññavānā Sutta, Jivapannavānā; Jalacara-Sthalacara -Khecara-manuṣyaprajñāpanā 29-34; Sthānapayaṁ, Paññavānā 2.

7. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 43-62.

8. It is suggestive from the study of the world of life in Jaina Biology on the basis of the structures (saṁthānas) of living forms—plants and animals, on the physiologic and biochemical similarities and differences between species, etc. and on the analysis of the genetic constitution of present plants and animals, i. e. anatomy, physiology and biochemistry of plants and animals, their embryologic and genetic histories as outlined in Jaina Biology and the manner in which they are distributed over the earth's surface, that a sort of organic evolution has occurred.

9. Sūtrakṛtāṅga II, 3.43-62; Bhagavatī, 7.5.282; 'The habitat of an organism is the place where it lives, a physical area, some specific, earth surface, air, soil or

organism may provide food or shelter for another¹⁰ or produce some substance harmful to the second.¹¹

The Classifications of Living Substances

The Jainācāryas have tried to set up systems of classifications based on natural relationships,¹² putting into a single group those organisms which are closely related in their evolutionary origin.¹³ Since many of the structural similarities¹⁴ depend on evolutionary relations,¹⁵ classification of organisms is similar in many respects to the one of the principles based on logical structural similarities,¹⁶ that is to say, species, genus, and phyla. Many plants and animals fall into easily recognizable, natural groups and their classification presents no difficulty.

The vedic sages also have described and classified plants and animals. The Vedic Index of Names and Subjects of Macdonell and Keith¹⁷ and Vanaspati¹⁸ of Mazumdar reveal a large number of plants and animals

water", Biology, p. 30. It is a remarkable fitness of the organism for the place in which it lives, e. g. water for aquatic animals and plants, land for terrestrial animals and plants, and air for aerial beings. It is suggestive from this fact of fitness of the organism for the habitats in which they live that they are interacting and interdependent parts of large units for survival as evidenced by a close study of Āhāranikṣepa (Knowledge of food) in the Sūtrakṛtāṅga II, 3.43-62.

10. Sūtrakṛtāṅga II, 3.43-62.
11. Bhagavatī Sūtra 8.2.316.
12. e. g. ekendriya, dvendriya, trīndriya, caturindriya and pañcendriyo organisms are classified on the basis of natural relationships. Similarly, Jalacara and Khecara organisms are classified according to their natural relationship, as they are closely related in their evolutionary origin.
13. Sūtrakṛtāṅga, II, 3; Jivābhigamasūtra, 3.1.96; Bhagavatī Sūtra 7.5.282 (aṇḍaja, potaja and saṁmūrcchīha); Uttarādhyayana Sūtra, 36.171 ff; Jivābhigama Sūtra, 33.1.34, 35; Pañnavanā Sutta, Jivapañṇavahā, (Jalacara, Sthalacara and Khecara and Manuṣyaprajñāpanā) 29-34. Aquatic, terrestrial and aerial organisms have been classified into three single groups as the members of each of them are closely related in their evolutionary origin.
14. Bhagavatī Sūtra 8.3.324, 7.3.277, 7.5.282; Jivābhigama Sūtra, 3.1.91, 1-33, 1-34, 1-35, 1-36; Uttarādhyayana Sūtra, 36.135, 144, 154, 169, 178, 179-186, 193, 202; Pañnavanā Sūtra, Sthalacaratiraścām catuṣpada-parisarpeti bhedadvayāṁ, p. 30, Catuṣpādānāṁ ekaksurādiksuraśādi bhedacatuṣpāda, p. 30. Gaṇḍipadānāṁ hastipūyanaya (di)ādinamakadāmbakam, p. 31, Sanakhapadānāṁ, vyāghrādīnūmakadāmbakam, p. 31, etc. (contents); Tattvārthasūtra 2-24, 34.
15. Ibid.
16. Ibid.
17. Macdonell, A. A., and Keith, A. B., Vedic Index of Names and Subjects I and II, John Murray, London, 1912.
18. Mazumdar, Vanaspati, University Press, Calcutta, 1927, pp. 234-254.

(see also Aiyer),¹⁹ the equivalent scientific names of which have been given by the experts. There is mention of about 739 plants²⁰ and over 250 animals in the ancient literature. The whole 24th chapter of the Yajurveda embodies valuable materials on Zoology.²¹ A bewildering variety of birds, and about 21 kinds of snakes are described, each distinct by its own particular features of colour, structure or habit. There is also mention of microscopic organism—bacteria, and insects of terrestrial and aquatic organ²² and fish.²³

Distinctions Between Plants and Animals

The living world may broadly be divided into two kingdoms, one of plants²⁴ (vanaspati) and one of animals (paśu)²⁵ on the basis of the category of Tairyagyanā²⁶ (lower animals) in Jaina Biology. The word ‘ Vanapphai ’²⁷ (plant) suggests trees, shrubs, flowers, grasses and vines—large and familiar objects of every day world. And the word ‘ paśu ’²⁸ indicates both wild²⁹ and domestic³⁰ animals in a wider sense, such as, lions, tigers, cows, buffaloes, birds, frogs, fish, etc.

In the Vedic literature also the plant kingdom has been divided into trees, herbs, shrubs, creepers and grasses.³¹ The term ‘ Vṛkṣa ’³²

19. Aiyer, A. K. Y. N., Agriculture and Allied Arts in Vedic India, Bangalore Press, Bangalore, pp. 32-45, 1949.
20. Shastry, V. R., Science in the Vedas, Bulletin of National Institute of Science of India, No. 21, p. 102, 1963.
21. “ Aśvastuparo gomṛgaste prajapatyāḥ, etc.” Yajurveda, 24th chapter.
22. Śrinivāsa Rao, History of our Knowledge of the Indian Fauna through the Ages, Journal of Bombay National History Society, 54, 251-280, 1957.
23. Macdonell, A. A., and Keith, A. B., op. cit., p. 510; 1012. See Biology in Ancient and Medieval India, Dr. R. N. Kapil, vide The Indian Journal of History of Sciences, Vol. 5, No. 1, 1970, p. 126, for all these references.
24. Bhagavatī 24.16.707 (Birth of plant-bodied beings).
25. Ibid. 3.1.134; 11.9.417.
26. Tattvārthādhigama Sūtra II, 6; Brāhmaṇgrahani, Śricandrasūri, vv. 419-434, pp. 234 242; Tiryaṁcaḥ pūṁcadhaikākṣā : ikāḥ “ Pāṁcākṣasimākṣāḥ 1 ”, Lokāp akāśa 4.16; Gommaṭasāra (Jiva) 146.
27. Bhagavatī 24.16.707; 33.1.844.
28. Bhagavatī Sūtra, 3.1.134; 11.9.417.
29. Ibid. 7.3.288.
30. Ibid. 5.3.325.
31. Yāḥ phalinīrā aphaṭā apuṣṭā yāśca puṣṭinīḥ, Rg. Veda 10.97.15; “ Dvā Sūparṇā sayuṣā sakhyā samānām vṛkṣām paripasvajate / Tayoranyāḥ pippalam svādva-ttyānaśnannanyo abhicākaśī // ”, Rgveda i. 164-20; “ Yas nīn vṛkṣe madhyadāḥ sūparṇā nivīṣante suvate cādhiviṣve / Tasyedāhuḥ pippalam svādāgṛe tānnonna-sadyāḥ pitaram na veda ” // Ibid., 164 22; “ Osadhayaḥ ”, Atharvāveda viii.7.
32. Vedic Index I, p. 125

stands for trees in the *Rgveda*³³ and the word 'Osadhi' or 'Virudh' denotes minor vegetable growths like herbs.³⁴ The plants which come under 'Osadhi' contain the healing power,³⁵ while those under the head of 'Virudh' does not have medicinal properties.³⁶ The word 'Tr̄ṇas' denotes grasses.³⁷ The word 'Paśu'³⁸ in the Vedic texts indicates animals including man, while the word 'Jagat' stands for domestic animals as against 'Śvāpada' (wild animals).³⁹

Further thought about the world of life brings to mind such forms of life, such as, mushrooms⁴⁰ and pond scums (*sevāla*),⁴¹ etc. quite different but recognizable as plants, and insects,⁴² worms,⁴³ etc. that are definitely animals.

Fundamentally, plants and animals, as mentioned in the Jaina Āgamas are alive in many ways, both are made of cells⁴⁴ as structural and

33. "Adhvaryavo apo vavrvivāṁsam vṛtrāṁ jaghānāśanyeva vṛkṣāṁ", *Rgveda*, 2.14.2; "Grāvāneva tadiarthāṁ jārethe gr̄dbhreva vṛkṣāṁ nīdhimantamaccha/", *Ibid.* 2.39.1.

34. "Na tat pṛthivyāṁ no divi yena prāṇanti virudhah /", *Atharvaveda* 1.32.1.
 "Tyāṁ virunmadhujātā madhunā tva khanāmasi /
 madhoradhi prajātā sā no madhomataskṛdhi /" *Atharvaveda*, 1.34.
 "Aghadviṣṭā devajātā virucchapathayepani /
 Āpo malamiva prāṇaikṣit sarvān macchapatāḥ adhi /", *Ibid.*, ii. 7. 1.
 "Tve agne viṣe amṛtāsō adruha āsā devā haviradantyāhutāṁ /
 Tvayā martasāḥ svadanta āsutām tvāṁ garbhī virudhāṁ jajñiṣe sūchih /"
Rg. Veda, 2.1.14.

35. "Yā oṣadhiḥ pūrvā jātā devebhyāstriyugāṁ purā /", etc. *Rg. Veda*, 10.97.1 22.
 "Oṣadhyāḥ phalapākāntāḥ", *Amarkosa*, 661.
 In Jaina lit. nature also oṣadhi denotes cereals-such as, sāli, bṛihi, etc.
Vedic Index I, d. 125.

36. Pṛthivīmanu vyārcchat tadoṣadhayo virudho abhavantsa prajāpatimapādhāvadvītrāṁ me jaghnuṣā indriyāṁ vīryāṁ /", *Taittiriya Saṁhitā*, 2. 5, 3. 2.
Vedic Index, p. 125.

37. "Kīmu śreṣṭha kīm paviṣṭho na ājaga.....
agne bhrātarḍruṇā ida bhūtimūdima /" *Rgveda*. 1.16.1.
 "Yad vā ghvāsyā prabhṛtamāsye, tṛṇāṁ sarvā /", etc. *Ibid.* 1.162.8.
 Nāsmai tṛṇāṁ nodakāmā....etc. *Ibid.*, 10.102,10.

38. *Vedic Index I*, p. 509; *Taittiriya Saṁhitā*, 4.2.10, 1-4.

39. "Uttamo asyoṣadhiṁāmanāṅgivān jagatāmivāḥ vyāghrah śvāpadāmiva /"
Atharvaveda VIII. 5. 11; Vedic Index, p. 268.

40. Kuhana (a kind of mushrooms which causes the earth to burst) *Uttarādhyayana Sūtra*, 36.95.

41. *Sevāla*, See *Sūtrakṛtāṅga* II, 3. 55.

42. (*Kunthus*), *Uttarādhyayana Sūtra*, 36.127.

43. *Uttarādhyayana Sūtra* 36.128. (*Kṛmi*).

44. *Abbyaya* (cell), etc. *Tandulaveyāliya* V. 2, p. 6.; See the third section of the 1st chapter.

functional units and both have many metabolic processes⁴⁵ in common. But there are some obvious ways and some obscure ways in which they differ.

Plants' cells, in general, secrete a hard outer cell wall of cellulose (tvac)⁴⁶ which encloses the living cells and supports the plant, while animal cells⁴⁷ have no outer wall and hence can change their shape. But there are some plants⁴⁸ without having cellulose walls and one group of animals, the primitive chordates,⁴⁹ having cellulose walls around their cells.

Secondly, plant growth generally is indeterminate,⁵⁰ that is, plants keep on growing indefinitely because some of the cells remain, in an actively growing state throughout. But although the cells of animals are replaced from time to time, the ultimate body size of most animals is established after a definite period of growth.⁵¹

A third difference between the two types of living substances is that most animals are able to move about (trasa),⁵² while most plants remain fixed in one place (sthāvara),⁵³ sending roots into the soil to obtain liquid substances and getting energy from the sun⁵⁴ by exposing broad flat surfaces. Of course there are exceptions to both of these distinctions.

The most important difference between plant and animal is their mode of obtaining nourishment.⁵⁵ Animals move about (trasa) and obtain their food from organisms in the environment, but plants are

45. Tarkarahasyadīpika Tīkā on V. 49, Guṇaratna on Saḍdarśanasamuccaya.; See the fourth section of the 1st chapter.

46. Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3, Sūtra 47 (TVac).: Gommaṭasāra (Jivakāṇḍa), 188, 189 (Challi).

47. Ibid. They have ajina (skin), Sūtrakṛtāṅga II, 2.18.

48. e. g. Bulbous plants, like onion, garlic, etc., have no cellulose walls.

49. e. g. some fishes, amphibia, reptiles-vertebrate animals have cellulose walls around their inner cells.

50. "Vanaspatiśarīramāṇikura Kisalayaśākhāprāśākhādibhirvīśeṣaiḥ pratiniyatām Vardhata iti /", Tarkarahasyadīpika Tīkā on V. 49, p. 137.; Plant's duration of life is ten thousand years in maximum. Uttarādhyayana, 36.102.

51. Uttarādhyayana Sūtra 36.132, etc. animals life is shorter than that of plants. See Tarkarahasyadīpika (Tīkā), on V. 49.

52. Ācārāṅga Sūtra, Book I, 9.114; Sūtrakṛtāṅga II, 2.18; Sthānāṅga Sūtra 2.4.100; Bhagavatī Sūtra, 35.4.739; Uttarādhyayana Sūtra, 36.68; Pañṇavānā, Kayadvāra, p. 86; Jivābhigama Sūtra, p. 11; Tattvārtha Sūtra II, 12- 4; Mūlācāra, Pt. I, 30 (226), p. 295; Jivavicāra 2; Tarkarahasyadīpica, Tīkā on V. 49; Gommaṭasāra (Jiva) 3.

53. Ācārāṅga 1.9.114; Sthānāṅga 3.1.164; Uttarādhyayana 36.69; Bhagavatī 25.4.739; Pañṇavānā 4.232, p. 87 (Kayadvāra); Tattvārtha Sūtra 2.11.

54. Bhagavatī Sūtra, 7,3.275-6.

55. Sūtrakṛtāṅga IJ, 3.

stationary (sthāvara)⁵⁶ and manufacture their own food, with the exception of fungi and plant bacteria, which feed on the sap of other plants⁵⁷ or humour of other living or decaying things.⁵⁸ In conclusion it can be summed up that plants may be classified into bacteria,⁵⁹ algae,⁶⁰ fungi,⁶¹ herbs,⁶² shrubs,⁶³ creepers⁶⁴ grasses⁶⁵ and trees⁶⁶ on the basis of general properties of green plant cells, the structure and functions of a seed plant, reproduction, etc. Microscopic bacteria (i. e. earth up to plant-bacteria), insect and animals of terrestrial⁶⁷ and aquatic⁶⁸ origin and aerial beings⁶⁹ find mention with their distinct classifications in the Jaina Āgamas. It appears that plants and animals were classified into species and genus, etc. on the basis of certain principles, such as, birth, habitat, living, special structural features, utility, etc., i. e., evolutionary descent and ecology in general.

Mode of Nutrition of Plants and Animals

According to Jaina Biology, some organism can synthesize their food.⁷⁰ They may be called autotrophic (self-nourishing), e. g. green plants⁷¹ and purple bacteria,⁷² (Sulphur bacteria = Saugandhie) some

56. Ibid.

57. Ibid.

58. Ibid.

59. Sūkṣma vanaspati (subtile plant) of one class may be identical with bacteria of modern Biology; see Uttarādhyayana Sūtra, 36.100.

‘Egavihāmanānattā, suhumā tattha viyāhiyā / Suhumā savvalogammi...../’

60. Algae may be indentified with Sevāla, the aquatic plant, Vallisneria and other water plants, etc.; see Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 55.

61. Fungi lacks chlorophyll. It may be idenified with some of the subtile plant bacteria, growing on other objects, See Uttarādhyayana Sūtra 36-92. See SBE. XLV, p. 95.

62. Bhagavatī Sūtra 21.7.(91; ‘Hariyakāya’, Uttarādhyayana Sūtra 36.95.

63. Uttarādhyayaha Sūtra 36.94; Gumma, similar to Guccha, e. g. Vrintāka Soldnum, but, bring forth twigs on stems, instead of stalks, e. g. Navamālikā Jasminum Sambac, Kanavīra, etc. See SBE. XLV, p. 216.

64. Bhagavatī Sūtra 21.5.691; 21.6.691; 23.1.691; 23.4.693; Uttarādhyayana Sūtra 36.9.4

65. Bhagavatī Sūtra 21.5.691; 21.6.691; 11.9; 427; 12.8.459; 12.4.692; etc. Uttarādhyayana Sūtra, 36.94 (tana).

66. Bhagavatī Sūtra, 22.2.693; 22.3.692; 22.4.692; 23.1.693; 23.3.693; 23.4.693; 23.5.693; etc.; Uttarādhyayana Sūtra 36.94 (Rukkha).

67. Sūtrakṛtāṅga II, 3; Bhagavatī Sūtra 7.5.282; Uttarādhyayana Sūtra 36.71; Paṇṇavaṇā Sutta, Tiikkhajoniyā (Jivapaṇṇavaṇā), 61-91, p. 29.

68. Ibid.

69. Ibid.

70. Sūtrakṛtāṅga II, 3. 2.

71. Bhagavatī Sūtra, 7.3.275.

72. Sulphur Bacteria mentioned in the Uttarādhyayana 36.76 and Sūtrakṛtāṅga II, 3.61 may be identified with purple bacteria of Biology; see the Science of Biology Paul B Weisz, Forms of Nutrition, pp. 318-19.

organisms cannot synthesize their own food from inorganic materials, therefore, they must live either at the expense of autotrophs⁷³ or upon decaying matter.⁷⁴ They may be called heterotrophs. All animals, fungi and most bacteria are heterotrophs.

It is stated in the *Sūtrakṛtāṅga* that some organisms (trees) feed on the liquid substance of the particles of earth, the origin of various things; these beings consume earth-bodies, water-bodies, fire-bodies, wind-bodies, bodies of plants, they deprive of life the bodies of manifold movable and immovable beings; the destroyed bodies which have been consumed before, or absorbed by rind (are) digested and assimilated (by them)...⁷⁵ That is to say, some organisms (trees or plants) are self-nourishing and they can synthesize their own food from inorganic materials and bodies of plants, while some holozoic organisms among plants (like pitcher-plants) must constantly find and catch other organisms—movable and immovable. They consume, digest and assimilate them. Therefore, they must live at the expense of others—autotrophs or heterotrophs. Some organisms born in trees, originated by trees, sprung from trees, springing from trees that originated in earth come forth as trees originated by trees, feed on the sap of the trees originated in earth (3).⁷⁶ That is parasitism, heterotrophic nutrition found among both plants and animals.

That is to say, “Parasite lives in or on the living body of plant or animals (called the host) and obtains its nourishment from it. Almost every living organism is the host for one or more parasites.”⁷⁷

Some creepers feed on the liquid substance of the particles of earth and the sap of tree, also (6-9),⁷⁸ i.e., they are both autotrophic and parasitic.

In the same way grass, herbs and plants also feed on the liquid substances of the particles of earth (10-15),⁷⁹ etc. Here it is suggestive that a few plants like the mistletoe are in part parasitic and in part

73. *Sūtrakṛtāṅga* II, 3.10, 21, 22-28, 29. All animals live at the expense of autotrophs in one way or other except some carnivorous animals.

74. *Ibid.* II, 3.16. Fungi and some bacteria feed on the decaying matters, as it is found that some beings born in earth, growing there in particles of earth that are the origin of various things, some issue forth as Āya, Kāya mushroom (Kuhana) etc. from the decomposed things in the earth.

75. *Sūtrakṛtāṅga* II, 3.1.

76. *Ibid.* II, 3.3. Some parasitic plants live on the sap of the host plants.

77. Biology, p. 85.

78. *Sūtrakṛtāṅga* II, 3 (6-9).

79. *Ibid.* II, 3 (10-15).

autotrophic, for although they have chlorophyll and make some of their food, their roots grow into stems of other plants, and they absorb some of their nutrients from their hosts.⁸⁰

Some organisms born as aquatic plants, such as, *Udaga*, *Avāga*, *Panaga*, *Sevāla (algae)*, etc. feed on the particles of water, etc. (18).⁸¹ They belong to the type of autotrophs which can synthesize their own food from inorganic materials.

Some organisms born as movable beings from trees born in earth, trees originated by trees from the roots, seeds, etc. produced by trees, originated by creepers born on trees, from creepers born on creepers, from the roots, etc. of creepers born on creepers, from grass, from herbs, from plants, from *Āya* down to *Kūra* born in earth, from trees born in water, from *Udaga* up to *Pukkhalatthibhaga* born in water (19) feed on the sap of the trees, creepers, grass, herbs, plants, be they born in earth, or water, on trees or creepers or grass or herbs or plants; (the sap) of their roots, down to seeds of *Āyas*, etc. of *Udakas*, etc. And these creatures consume earth bodies, etc., assimilated by them.⁸² It is the well known fact in India that the parasitic insects and pests are born in the host plants and destroy thousands of trees and crops including paddy and wheat, etc. by feeding on their sap.

These parasites are movable beings and many obtain their nutrient by ingesting and digesting solid particles or absorbing organic molecules through their cell walls from the body fluids or tissues of the host.

The children of the developing embryos at first feed on the menses of the mother and the semen of the father or both combined into unclean, foul (substance). And afterwards they absorb with a part (of their bodies) the essence of whatever food the mothers take. After birth the babies suck the mother's milk but when they grow older, they eat solid rice or gruel, or both movable and immovable beings consume earth bodies, etc. upto assimilated by them (21).⁸³

This mode of nutrition of human beings is scientifically true and it may be called heterotrophic nutrition.

Aquatic animals of five organs of sense, viz., fishes up to porpoises, (*sirumāra*) feed on the mother's humours, as long as they are young, they eat plants, or both movable and immovable beings (22).⁸⁴

80. Biology, p. 85.

81. *Sūtrakṛtāṅga* II, 3.18.

82. *Ibid.* II. 3. 19-20).

83. *Sūtrakṛtāṅga* II. 3.21.

84. *Ibid.* II, 3.22.

This scientific observation of the mode of nutrition of aquatic animals is biologically true. The quadrupeds, terrestrial animals with five organs of sense, viz. solidungular animals, biugular animals, multi-ungular animals, and animals having toes with nails, feed on their mother's milk as long as they are young (23),⁸⁵ the rest as above.

Some of the reptiles moving on the breast, terrestrial animais with five organs of sense, viz. snakes, hung, snakes, Āśālika and dragons bring forth eggs, some bring forth living young ones, some come out of the egg as males, some as females, some as neuters. As long as they are young, they live on wind (24),⁸⁶ (the rest as above).

Terrestrial animals with five organs of sense, walking on their arms, are the following viz. iguanas, ichneumons, porcupines, frogs, chameleons, khoras, gparakoillas, vissambharas, rats, mangooses, pailaiyas, cats, gohās, Gāuppāiyas, (the rest as in the last paragraph.) (25).⁸⁷

Aerial animals with five organs of sense : birds with membranous wings, birds with feathered wings, birds with wings in the shape of a box and birds (which sit on) outspread wings.⁸⁸ (All as before only the following passage is different. As long as they are young, they are hatched by their mother's warmth (The test is above) (26).⁸⁹

It is clear from the above statements on the mode of nutrition of terrestrial, aquatic and aerial organisms that some of these heterotrophs live either at the expense of autotrophs or upon movable organisms and fungi and bacteria upon decaying matter.⁹⁰

There are several type of heterotrophic nutrition as there are various classes of heterotrophs. When food is obtained as solid particles that must be eaten, digested and absorbed, as in most animals; the process may be known as holozoic nutrition, i. e. Holozoic organisms must constantly find and catch other organisms for food.

The parasitic organisms (Anusūya = anusūta or anusyūta) growing on the animate or inanimate bodies⁹¹ of manifold movable or immovable creatures feed on the humours of various movable and immovable creatures (27).⁹²

85. Ibid. II. 3 23.

86. Ibid. II. 3.24.

87. Sūtrakṛtāṅga, II. 3.16; Vide SBE Vol. XLV, p. 395.

88. Sūtrakṛtāṅga II. 3. XLV, 395.

89. Āya. Kuhana (Mushroom), etc. feed on decaying matter.

90. i. e. decomposed bodies.

91. Sūtrakṛtāṅga II, 3 27.

92. Ibid. II. 3.28-9.

In this way the vermin also feeds on the humours of living animals (28, 29). It means that the parasites may obtain their nutrients by ingesting and digesting solid particles or by absorbing organic molecules through their cell-walls from the body fluid or tissues of the host.

Some organisms born in the animate or inanimate bodies of manifold movable or immovable creatures as that (water)-body, which is produced by wind, condensed by wind, and carried along by wind, e. g. hoar-frost, snow, mist, hailstones, dew and rain, feed on the humours of these manifold movable and immovable creatures (30),⁹³ etc. Some beings born in water, come forth in water(-bodies) in the water, produced by manifold movable or immovable beings, feed on the humours of the water (bodies) produced by manifold movable and immovable creatures (31).

Some beings born in water come forth in water-bodies produced by other water-bodies and feed on the humours of these other water bodies produced by water-bodies (32).

Some beings born in water, come forth as movable creatures in the water produced by water-bodies and feed on the humours of the water (bodies) produced by water (33).⁹⁴

Some beings come forth as fire-bodies in the manifold animate or inanimate bodies of movable or immovable creatures and they feed on the manifold movable or immovable creatures (34).⁹⁵

Some beings born as wind bodies feed on the manifold movable or immovable creatures (35).⁹⁶

Some beings born as earth-bodies, e. g. earth, gravel, etc., feed on the humours of the manifold movable and immovable beings (36).⁹⁷

93. *Sūtrakṛtāṅga*, II. 3.30. This paragraph gives the 'scientific' explanation of the way by which water bodies or the bodies of water-lives are produced by wind. SBE. XLV, p. 396, fn. 2.

94. *Sūtrakṛtāṅga* II. 3. (31-33). This statement on the mode of nutrition of water-bodied beings or bacteria needs scientific experiment and verification for its validity. It is difficult to suggest their true identifications at the present state of knowledge about them on the basis of the Āgamas.

95. *Ibid.* II. 3.34. e.g. when two bulls or elephants rush upon one another, sparks of fire are seen issuing from their horns or teeth. Fire is produced when two pieces of wood or stone are rubbed one against the other, SBE. XLV, p. 397, Fn. 1.

96. *Ibid.*, II. 3.35.

97. *Ibid.*, II. 3.36. According to the commentators, earth-bodies are produced in the shape of precious stones, in the head of snakes, of pearls in the teeth (six) of elephants, and so in reeds, e.c., SBE XLV, p. 397, Fn. 2.

These modes of nutrition of water-bodied, fire-bodied, wind-bodied and earth-bodied beings as described in the *Sūtrakṛtāṅga* need a careful study and scientific verification by the biologists in the light of modern Biology before accepting them as true, as they are thought-provoking.

ECOSYSTEM

It appears from the study of the mode of nutrition of all organisms including plants, aquatic, terrestrial and aerial beings, and man, etc. as described in the Jain Āgamas that plants and animals are not independent of other living things but are interacting and interdependent parts of larger units for survival. So their interaction and interdependence bring to light that ecosystem which is a natural unit of living and non-living parts that interact to produce a stable system in which the exchange of materials between living and non-living parts follows a circular path, e. g., aquatic organisms-fish, green plants and snails (*śambuka*)⁹⁸ form a very small ecosystem in their habitat-water in a pond or lake.

It has been observed in the discussion on the mode of nutrition that there are "producer" organisms⁹⁹—the green plants that can manufacture organic compounds from the simple inorganic substances drawn up from the earth or water, etc. Secondly, there are "consumer"¹⁰⁰ organisms—Insects and insect larvae in the plant-bodies, etc. and fish etc. in water, which may be carnivores. Finally, there are "decomposer"¹⁰¹ organisms, bacteria, and fungi which break down the organic compounds of dead protoplasm of the dead bodies of plants and animals into organic substances that can be used by green plants.

Thus, Jain Biology suggests an ecosystem consisting of biotic components—producer, consumer and decomposer organisms and non-living compounds i. e. abiotic components—earth, air, water and fire.¹⁰²

Habitat and Ecologic Niche

A brief analysis of ecosystem of Jaina Biology brings to light two

98. *Tattvārthādhigama Sūtra*, 2.24,
99. *Sūtrakṛtāṅga* II, 3.2. Trees (plants) feed on the liquid substance of the particles of earth, consume earth-bodies, etc. by manufacturing organic compounds from the inorganic substances.
100. *Sūtrakṛtāṅga* II, 2.19-20; II, 2.22; II, 2.27, 28, 29.
101. *Sūtrakṛtāṅga* II, 3.16. Āya, Kuhana (mushroom), etc. are born in the decaying matters because bacteria break down the organic compounds of dead protoplasm of dead plants and animals into organic substances which can be used by green plants.
102. *Sūtrakṛtāṅga* II, 3.

basic concepts—the habitat¹⁰³ and the ecologic niche¹⁰⁴ useful in describing the ecologic relations of organisms, i. e. the place where an organism lives, a physical area, some specific part of the earth's surface, air, soil or water,¹⁰⁵ and the status of an organism within the ecosystem.

It depends on its structural adaptations, physiologic responses and behaviour, etc.—what it eats¹⁰⁶ and what eats it,¹⁰⁷ its range of movement and tolerance and its effects on other organisms and on the non-living parts of the surroundings.¹⁰⁸

Type of Interactions Between Species of Plants and Animals

The study of the knowledge of food of organisms, the third lecture of the second Book of the Sūtrakṛtāṅga, throws some light upon the types of interactions between species of plants and animals in several different ways, which take place due to their search for food, space, or some other need, e. g. the relationship of competition,¹⁰⁹ or predatism, commensalism,¹¹⁰ mutualism,¹¹¹ parasitism¹¹² as found between them.

103. Sūtrakṛtāṅga II. 3. 1-12; 3 (trees), 16 (soil), 17 (water), 18 (trees), 21 (earth), 22 (water), 23 (earth surface), 36 (aerial), 27 (animate or inanimate bodies).
104. Sūtrakṛtāṅga II. 3.2, (liquid substance) of the particles of earth, the bodies of manifold movable and immovable beings, 3-5 (sap of the trees), 20 (sap of trees), 21 (mother's milk, boild rice, etc.), 22 (mother's humours and plants), 23 (both movable and immovable beings), 24 (wind), 27 (the humours of various movable and immovable creatures).
105. Sūtrakṛtāṅga II. 3.30. 33 (water), 34 (fire), 35 (wind), 36 (soil).
106. Sūtrakṛtāṅga, II. 3.30. (liquid substance), etc. See Foot Note on page 14, Foot Note No. 5.
107. Sūtrakṛtāṅga II. 3.27; i. e. The parasites feed on the humours of various movable and immovable creatures—animals and plants.
108. Sūtrakṛtāṅga II. 3. The entire chapter—'knowledge of food' throws light upon behaviourism of plants and animals in addition to their mode of nutrition and reproduction.
109. Some beings (trees) deprive of life the bodies of manifold movable and immovable beings; the destroyed bodies which have been consumed before, or absorbed by the wind (are) digested and assimilated (by them), Sūtrakṛtāṅga II. 3.2.
110. Some beings born in trees, originated by trees, spring from trees, spring from trees that originated in earth, come forth as trees originated by trees. They feed on the sap of the trees originated in earth, 1bld. II. 3.3.
111. The relations of nitrogen-fixing bacteria and legumes and algae and fungi in lichens. See Bhagavati 7.3.275 (plant bacteria); Sūtrakṛtāṅga II, 3.5. 16 (kuhāna), 18 (sevāla), 2 etc.
112. Some organisms growing on the animate bodies of manifold movable or immovable creatures, come forth as parasites. They feed on the humours of various movable and immovable creatures. Sūtrakṛtāṅga, II. 3.27.

The 'host-parasite or predator-prey-relationship may be harmful to the host or prey as a species when such relationship is first set up. But the study of different examples of parasite-host, and predator-prey interrelations shows that "in general, where the associations are of long standing, the long-term effect on the host or prey may not be very detrimental and may even be beneficial."¹¹³

The brief survey of the classifications of living things—plants and animals, their distinctions, mode of nutrition, ecosystem, habitat and ecologic niche, and types of interactions between species as found in the Jaina Agamas gives a picture of the world of animals and plants, all related closely or distantly by evolutionary descent, and bound together in a variety of inter-specific interactions.

113. Biology, p. 93.

Second Section

General Properties of Green Plant Cells

It appears from the study of plant-life as explained by the Jainācāryas that the green plants¹ are the primary producers of the living world. The properties of the pigment that gives them their green colour, i. e. chlorophyll, enable them to utilize the radiant energy of sunlight to synthesize energy-rich compounds, such as, liquid substances (siñeha)² from water and air³ (carbon-dioxide). The process of photosynthesis is the only significant way in which energy⁴ (teja) from the sun is made available for life on this earth.

Land-plants⁵ absorb the water required for the photosynthetic process through their roots; aquatic plants⁶ receive it by diffusion from the surrounding medium. Plants need vast quantity of air to carry on photosynthesis, for air contains carbon-dioxide. "Plants generally grow better in air with higher carbon-dioxide content."⁷

Cellular Respiration of Plants

The taking of air (vāyuśarīram)⁸ by plants suggests that the cellular respiration⁹ of plants which is the series of enzymic reactions utilizes ucchvāsavāyu¹⁰ (oxygen) and releases niñvāsavāyu¹¹ (carbon-dioxide?)

1. Sūtrakṛtāṅga II.3.43, etc.; Bhagavatī Sūtra, 7.3.275; Uttarādhyayana Sūtra 36.92-99ff; Paññavānā Sutta, Vanaspatikāyajivapaññavānā, 35-54.5; Lokaprakāśa I, 5th Sarga, Vanaspati.
2. "Te jīvā.....puñhavīnām siñehamāhāremti te jīvā ahāremti puñhavīsarīram āśasarīram teusarīram vāyusarīram vanassaisarīram, 1" etc. Sūtrakṛtāṅga II. 3.43.
3. Ibid (āu-ariām.....vāusarīram).
4. Ibid (teusarīram).
5. "Mūlam syāt bhūmisambaddham tatra kandaḥ samūśritah / Tatra skandha iti mitho bijāntah syuryutah same (107) Atah pṛthvīgatarasamāhāraṇti same apyamī / Yāvat phalāmī puṣpastham bijāni phalasamāgatām" //108//, Lokaprakāśa I, Sarga 5, vv 107-8; See Bhagavatī Sūtra 7.3.276.
6. "Nāñāvihajōniesu udaeśu rukkhattae viuṭtamī, te jīvā tesiṁ nāñāvīhajōnīyānam udagānam siñehamāhāremti /" etc., Sūtrakṛtāṅga II. 3.54.
7. Sūtrakṛtāṅga, II. 3.43. (Vāusařīram). "Te jīvā ahāremti.....(Vāusarīram)
8. Biology, p. 97, C. A. Villee
9. Sūtrakṛtāṅga, II. 3.43.
10. "Te jīvā ahāremti.....vāyusarīram," Sūtrakṛtāṅga II. 3.43.
"śārirocchvāsanīñvāsāhāraḥ sādhāraṇāḥ khalu /" Lokaprakāśa 5, 75, p. 36.
11. "Mūle sikteśu vṛkṣeśu phalādiśu rasah sphuṭah sa cocchvāsamaṇtareṇa kathamūrdhvām pṛasārpati" //32//; "Rasāprasārpaṇām satyucchvāse asmadādiśu / Tadabhaवे tadabhaवे dṛṣṭasāc mṛṭakādiśu" //33//, Lokaprakāśa, 5.32, 33, p, 353; Navatattvaprakaraṇam, p. 14.
12. Lokaprakāśa, 5.75, p. 361; "Prāñāpānāvucchvāsanīñvāsākriyālakṣaṇau /" Navatattvaprakaraṇa, p. 14.

from the liquid substance (siñeha or rasa) to the forms of biological useful energy. These occur in green plants as they do in every living cell.

The Skeletal System of Plants

Plants have no separate skeletal system for support as many animals do. At the simplest level, the śaivālas (algae)¹³ which are almost entirely aquatic have little need for specialized skeletal structures, for their bodies are generally small and supported by the water. The land plants¹⁴ do need some structure strong enough to hold leaves in position to receive sunlight.

This has been achieved in two major ways: the cellular wall (tvac)¹⁵ can be very thick,¹⁶ as in the woody stems of trees and shrubs, and serve directly for the support of the plant body or it can be rather thin¹⁷ (kaniyāsi) and provide support indirectly by way of pressure.

Besides, trees and shrubs have gūdhaśīrā (Xylem ? and ahiruyam (Phloem ?)¹⁸ to help support their trunk.

Plant Digestion

Plants have no specialized digestive system; their nutrients¹⁹ are either made within the cells²⁰ or are absorbed through the cell membranes.²¹ The nutrients synthesized are either used at once²² or transported to another part, such as, the stem or root,²³ etc. The

13. Sūtrakṛtāṅga II. 3.54.

14. "Puḍhavijoṇyā rukkhā", Ibid.

15. Sūtrakṛtāṅga II. 3.47; "Yatra skandhakāṁdamūlaśākhāsu khalu vikṣyate / Tvacā sthūlatara kāṣṭhāt sā tvacānantajīvīkā // " Lokaprakāśa I. 5.79, p. 363.

16. Ibid.

17. "Yatra mūlaskandhakandaśākhāsu dṛṣyate sphuṭam / Tvacā kaniyāsi kāṣṭhāt sā tvakpratyekajīva // " Lokaprakāśa, 5.96, p. 365.

18. Paññavānā, Vanaspatikāyajīvapaññavānā 54-84; Jīvavīcāra 12; Gommaṭasāra 187 (Jīvakāṇḍa).

19. "Te jīvā tesīm nāñāvihajoniyāṇam siñehamāhāreṇti", etc. Sūtrakṛtāṅga II, 3.43.

20. "Te jīva āhāreṇti puḍhavīṣarīram āusarīram teusarīram vāsūṣarīram vanassaisarīram, etc.", Ibid.

21. Ibid.; "Mūlāṇam syāt bhumiśambaddham tatra kandaḥ samāśritāḥ / tatra skandha iti mitho bijāntāḥ syuryutāḥ same //107// Atāḥ pṛthvīgataramāhāranti same' apyamī / Yāvat phalāni puṣṭapasthām bijāni phalasāṁgatām //108// " Lokaprakāśa, 5.107, 108.

22. "Tesīm puḍhavījoniyāṇam rukkhāṇam sarīrā nāñāvāṇṇā nāñāgāṁdhā nāñāphāsā nāñāsāṁdhānāsāṁthiya nāñāvīhasarīrapuggalaviuvvitā.....bhavāmītī tū / " Sūtrakṛtāṅga II, 3.43.

23. Te jīvā tesīm rukkhajoniyāṇam rukkhāṇam siñehamāhāreṇti....puḍhavīṣarīram, etc.....tesīm rukkhajoniyāṇam mūlāṇam kāṁdāṇam khaṁdāṇam tayāṇam pavālāṇam jāva bijāṇam sarīrā nāñāvāṇṇā nāñāgāṁdhā.....bhavāmītī / ", Ibid. II. 3.46.

insectivorous plants,²⁴ although without an organized digestive system, do secrete digestive enzymes²⁵ similar to those secreted by animals, as suggested by the statement "they deprive of life the bodies of manifold movable and immovable beings; the destroyed bodies which have been consumed before, or absorbed by the rind, (are) digested and assimilated (by them)."²⁶

Plants accumulate the reserves of organic materials for use during those times when photosynthesis is impossible, at night or over the winter²⁷ when leaves fall. An embryo plant cannot make its own food until the seed has sprouted and the embryo has developed a functional root,²⁸ leaf²⁹ and stem³⁰ system.

Plant Circulation

The simpler plants consisting of single cell or small group of cells³¹ have no circulatory system. Simple diffusion, augmented in certain instances by the process of active transport by air (ucchvāsavāyū)³² suffices to bring in the substance³³ the plant requires. Gūḍhaśīrās³⁴

24. नानाविहाना तसथावरानाम् पानानाम् सरिराम् अतितम् कुव्वाम्ति पौरिवद्दत्थाम् ताम् सरिराम्.....विपरिणायाम् सत्त्वियकादाम् सम्मताम् /', Ibid. II. 3.43.

25. Sūtrakṛtāṅga II. 3.43.

26. Ibid., SBE XLV, Book II, Lecture 3, Sūtra 2, p. 389.

27. Bhagavatī Sūtra, 7. 3.274, Vaṇassikāya.....Pāusavarisarattesu savvamābhāragā bhava अति, tada नानाम्तराम् ca नाम् sarae tayानाम्तराम् hemाम्ते tada नानाम्तराम् ca नाम् vasāम्ते tada नानाम्तराम् ca नाम् gimhe, gunhāsu नाम् vaṇassaiकाया savvappābhāragā bhava अति /' 274; Śrāvanādīcaturmāsyām prāvṛद्वर्षासु bhūruhaḥ / Sarvato bahulāhāra apām bāhulyataḥ smṛtāḥ //109// Tatha śaradi hemante kramādālpāl pabhojinaḥ / Yāvadvasante' alpāhāra griṣme atyantamitāśanāḥ " //110//, Lakaprakāśa I, 5, 109-10.

28. (1) "Joviya mule jivo soviya patte paḍhamayātti / (2) Savvo vi kisalao khalu uggamamāṇo anāmātāo bhaṇio " iti Etaccārthataḥ prajñāpanāvṛttau Ācarāṅgavṛttāvapi tathaiva // Yaduktām - " Yaśca mūlatayā jivāḥ pariṇamate sa eva prathama-patrata�ā api iti / ekajīvākārtṛke mūlaprathamapatre iti yāvat prathamapatrakām ca yāsau bijāsyā samutsūnāvastha bhūjalakālāpeksā saivocate / iti //na mūlajīvapariṇāmāvirbhāvitameva iti avagantavyām /", Vide Lokaprakāśa I, p. 361; " Udgacchan prathamānkuraḥ sarvasādāhāraṇo bhavet / Vardhamāno yathāyogam syātpratyeko' athavāparah //", Lokaprakāśa I, 5.74.

29. Ibid.

30. Ibid.

31. Uttarādhyayana Sūtra 36.92; Paññavānā, vanaspatikāyajivapaññavānā, 1.35, p. 16. (śūkṣma vanaspati)

32. Rasaprasarpanām spaṣṭām satyucchvāse asmadādiṣu / Tadabhlāve tadabhlāvo dṛṣṭāśca mṛṭakādiṣu //, Lakaprakāśa 5.33.

33. Ibid: Sūtrakṛtāṅga, II. 3.43.

34. Paññavānā Vanaspatikāyajivapaññavānā 54-84; Jivavicāra 12; Gommaṭasāra 187 (Jīvakāṇḍa).

(Xylem?) tubes are probably concerned with transporting water and minerals from the roots up the stem to the leaves, while ahiruyam³⁵ (phloem) tubes may probably transport nutrients up as well as down the stems for storage and use in the stems and roots, etc. In the spring and the summer,³⁶ for example, substances pass from the place of storage to the buds to supply energy for growth.

The circulatory systems of higher plants are simpler than those of higher animals and constructed on an entirely different plan. Plants have no heart and blood vessels. Transportation of their nutrients from the soil is accomplished by the combined forces of transpiration³⁷ pull and root pressure.³⁸

Plant Saps :

Plant sap (siñeha or rasa)³⁹ is somewhat analogous to the blood plasma of man and higher animals. It is a complex solution of many substances. Both organic and inorganic⁴⁰ which, as pointed out, are transported from one part of the plant to another by the combined action of suction force (ucchvāsa) which is connected with transpiration pull and root pressure.⁴¹ The substances present and their concentrations vary greatly in different plants and in various parts of the same plant.⁴²

35. Ibid.

36. "Vasaṁte tadāṇamātaram ca ṣaṁ gimhe, gimhāsu ṣaṁ Vaṇassaikāiyā savvappā-
hāragā bhavaṁti gimhāsu ṣaṁ bahave usiṇaṇoṇiā jīvā ya poggalā ya
vaṇassaikāiyattāe vakkamāmātī viukkamāmātī cayaṁti uvaṇajāmātī Gimhāsu
bahave vaṇassaikāiyā pattiyaṁ pupphiyaṁ phaliyā hariyagarerijjamānā sirie aiva
aiva uvasobhemānā uvasobhemānā cīḍhamātī /", Bhagavatī 7.3.274.

37. Mūle siktesu vṛkṣeṣu phalādiṣu rasāḥ sphuṭāḥ / Sa coccivāsamāntareṇa katham-
ūrdhvāṁ prasarati //32// Rasaprasarpaṇāṁ spaṣṭām satyucchvāse, asmadādiṣu /
Tadabhāve tadabbhāvo dṛṣṭaśca mṛtakādiṣu //33//, Lokaprakāṣa I. 5.32, 33, p. 353

38. Ibid., 5.107-8, pp. 367-8.

39. "Puḍhavīsu rukkhāttāe viuṭṭāmātī 1.....", "Te jīvā tesīm ṣāṇavīhājōṇiyanām
puḍhavīṇām siñehamahāremti 1", Sūtrakṛtāṅga II, 3.43; "Mūle siktesu vṛkṣeṣu
phalādiṣu rasāḥ sphuṭāḥ", Lokaprakāṣa V. 42; "Pratiniyatavīśiṣṭāśārīrātāsaviryā",
Tarkarahasyadīpika (Comm. on V. 47), p. 159.

40. "Te jīvā āhāremti puḍhavīsarāraṁ āusarāraṁ īcūsarāraṁ vāusarāraṁ vanassaisarāraṁ
(i. e. inorganic substances), ṣāṇavīhāṇa tasathāvarāṇām pāṇāṇām sarīraṁ
(organic substances) acittāraṁ kuvvāmātī pīrividdhatthaṁ tām sarīraṁ puvvahāriyām
tayāhāriyām vipariṇayām sārūhiyakaḍām saṁtām" Sūtrakṛtāṅga II. 3.43-44.

41. Lokaprakāṣa, I. 5.32, 33, p. 353.; 5.107-8, p. 367-8.

42. "Sākṣīrām vāpi niḥkṣīrām patrām gūḍhaśīrām ca yāt / Alakṣyamāṇapatrārddha-
dvayasandhi ca yadbhavet //84//", Lokaprakāṣa I, 5.84, p. 363.

Water is absorbed by the epidermal cells of the roots and moved to all parts of the plant.⁴³

Plant Excretion :

A striking difference between plants and animals as found in Jaina Biology is that plants excrete little or no waste (*khala*). Nitrogenous compounds may be released during the metabolic process of plant, but instead of being excreted as wastes, they are probably reutilized in the synthesis of new *paryāpti* (vital force).

Since plants are *lomāhārins*⁴⁴ (i. e. absorbers of nutrients through the epidermal cells of the roots, etc.) and they neither ingest proteins nor carry on muscular activity, like the *Kabalāhārin*⁴⁵ man and higher animals, the two largest sources of metabolic wastes in the animals), for “ the total amount of nitrogenous waste is small and can be eliminated by diffusion as waste through the pores of the leaves, or by diffusion as nitrogen containing salts from the roots into the soil ”⁴⁶ as explained by modern Biology.

Plant Co-ordination

The activities⁴⁷ of the various parts of a plant are much more autonomous than are those of parts of an animal. The co-ordination between parts that does exist is achieved largely by direct chemical and physical means,⁴⁸ since plants have developed no specialized sense-

43. *Lokaprakāśa*, I, 5.33; 5.107-8. pp. 367-8.

“ Mūlam syat bhūmisambaddhaṁ tatra kandah samāśritah /
Tatra skandha iti mitho bijāntāḥ syuryutāḥ same ” //107// *Ibid.* 5.107.

“ Atah pṛthvīgātarasamāhāranti same apyamī /
Yāvat phalāni puṣpasthaṁ bījāni phaṭasāmīgataṁ ” //108//, *Ibid.* 5.108.

44. *Lomāharā egimdiyā* ya/v. 200, *Bṛhatsangrahaṇi*, Ātmānanda-granthamāla *Ratāni*, 47
Ābhogāṇābhoga, savvesīm̄ hoi loma āhārō /”, *Ibid.*

45. “ *Sarīreṇa* oyahārō tayāi phāseṇa lomāharo; pakkheva puna, kavalio hoi nāyavvo ”, V. 181; *Sura niraya* igimdi viṇā, sesā bhavatthā pakkhevā V. 181. *Bṛhat Sangrahani*, 1st edition, VS. 1993.

46. *Biology*, p. 107, C. A. Villee

47. “ *Vanaspatiśāra* ramankurakisalayaśākhāprāśākhādiviśeṣaiḥ pratiniyatāṁ vardhata iti /”, *Tarkarahasyadipikā*, p. 157.; “ *Pratiniyatavṛddhi* svāpaprabodhasparśādi-
hetukollāsasāmkoṣṭayapasarpaṇādi viśiṣṭānekakriyā /”, *Ibid.*, p. 159.

48. “ *Yatha manuṣyaśāra* rasāyanasnehādyupayogādvīśakāntirasabalopacayādi
tathā vā *vanaspatiśāra* rasayāpi viśiṣṭeṣṭa nabhojalādisekādvīśārasavīryasnidhatvādi /”,
Ibid., p. 159.

organs except that of touch and do nervous system as found in man and higher animals. They have sensitiveness generated by stimulus.⁴⁹

Actively growing plants can respond to a stimulus⁵⁰ coming from a given direction by growing more rapidly or bend way from the stimulus.⁵¹

If an organism (e. g. creeper) is motile, it may respond to a stimulus by moving towards it for support.

When a seed is oriented in the ground in any way, the primitive root (mūla)⁵³ and shoot (aīkura)⁵⁴ of the developing embryo grow; the root grows downward and the shoot grows upward.⁵⁵ Thus the root positively geotropic and negatively heliotropic and the shoot is negatively geotropic but positively heliotropic.

Transmission of Impulse of plants

In a few plants responses to stimuli do occur rapidly enough to be readily seen. One of them is the response of the sensitive plant "Mimosa pudica" (Lajjāvatilatā).⁵⁶ Normally the leaves of this plant are horizontal, but if one of them is lightly touched, all the leaflets fold within two or three seconds.

Touching one leaf sharply causes not only the stimulated leaf, but also the neighbouring leaves, to fold and droop. After a few minutes the leaves return to their original position.

Sleep Movement⁵⁷ of plants

Many plants change the position of their leaves or flower parts in

49. Yathā manu-yaśarīram Jñānenānugatām, evenī vanaspatiśarīramapi, yathī śamip-
rapunnātāsiddhesarakāsundakabappulāgastyāmalkīkaṇiprabhṛtinām svāpavibodha-
tastadbhāvah / . . . tathā mattakāminīsanāpurāsukumāracaraṇatādānāśokatāroḥ
pallavakusumodbedāḥ / etc.. Ibid.. p. 157.
50. See Foot Note 6, Page No. 92.
51. Tarkarahasyadipikā, pp. 158-9; " Saṁjñā niyatasaṁkocavikāsapramukhāpapi
śaṁjñinām kathaṁtāmānām na jñāpayanti yuktibhīḥ // ", Lokaprakāśa, 5.38.
52. Tarkarahasyadipika. p. 159.
53. " Ambukālakṣmādirūpasāmag isambhaye sūti / Śa eva jātu bijāngī baddhatādṛśa-
kārmakah (II) V. 63. Utpadyate tatra, bije ano va bhūkāuikādikah ". Nibaddhaṁ-
lādināmagotrakarmatra jāyate " V. 64. Lokaprakāśa, 5.63-64.
54. " Udgacchān prathamān kūraḥ sarvasādhāraṇo bhavet / ", Lokaprakāśa, 5.74.
" Vanaspatiśarīramān kurakisalaya . . . vārdhata iti / ", Tarkarahasyadipikā, p. 157.
55. " Vanaspatiśarīramān kurakisalaya gākhāprāgākhādibhirviśeṣaiḥ pratiniyatām
vardhata iti / ", Tarkarahasyadipikā, p. 157.
56. " Tathā Lajjālūprabhṛtinām hastādisaṁsparśāt patrasaṁkocādipā parisphuṣakriyo-
paṭabhyate // ". Tarkarahasyadipikā, p. 158.
57. " Svāparabodhasparśādibetukollāśasāṁkocāśrayopasarpaṇādīviśiṣṭānekakriyā / ",
Tarkarahasyadipikā, p. 159.

the late afternoon or evening (*sāñdhyā*)⁵⁸ and their parts return to their original position in the morning. Several kinds of flowers close at night and open in the morning⁵⁹ with the sun-rise and some open at night with the rise of the moon⁶⁰ and closes in the day, e. g. lotus, (*padma*) and water lily (*kumuda*) respectively. These changes in position have been termed sleep movements in Botany, although they are in no way to related to the sleep of animals.

58. "Ghoṣātākāyādipuṣpāñāṁ ca sandhyāyāṁ /", Ibid., p. 158.

59. "Padmādīnāṁ prātarvikasāñāṁ /", Ibid., p. 158.

60. "Kumudādīnāṁ tu candra daye /", Ibid., p. 158.

(Third Section)

The Structures and Functions of A Seed Plant

It appears from the study of plant-life as treated in the Jaina Āgamas that in the more primitive plants the basic functions,¹ common to most green plant cells, may all occur in a single cell, but in the higher plants cellular specialization has occurred. The Jainācāryas differentiate the several parts - root (mūla), stem (khamdha), leaf (patra), etc.² of a plant. The evolution of conducting tissues (gūḍhaśirā and ahiruyin)³ and the specialization of regions or the body have enabled plants to survive on land and to grow to large size. Since these higher seed plants are the most widespread and familiar as well as the most useful plants for man, the Jainācāryas have dealt with some of the details of seed-plant structure and certain functions localized in particular parts of the plant.

The Roots and Its Functions

The most obvious function of the root is to anchor⁴ the plant and hold it in an upright position; to do this, it branches and rebranches extensively through the soil.⁵ The second and biologically more important function of the root is the absorption of water and minerals⁶ from

1. Sūtrakṛtāṅga II. 3.; Lokaprakāśa I, 5th Sārga.; Tarkarahasyadīpikā, Tīkā on V. 49, pp 157-159.
2. Rukkhajoṇiesu rukkhesu mūlattāe kāmattāe khamdhattāe tayattāe sālattāe pavālattāe pattattāe pupphattāe phalattāe biyattāe viuṭṭamī /", Sūtrakṛtāṅga, II. 3. 46.; "Mūlaggapirebājā kāmā taha khamdhabijabiaruhā /", Gommaṭasāra (Jivakāṇḍa), V. 186, "Kāmāssa va mūlāsa.....challi sāṇamātajiyā patteyajiyā tu taṇukadari /" Ibid., V. 189; "Etesi ḥām mūlā vi asāmkejjajiviyā, Kāmā vi Khamdhā vi tayā vi sālā vi pavātā vi / Paitā patteyajiviyā pupphā aṇegajiviyā, phalā egaṭṭhiyā /" Paṇṇavaṇā, Vanassaikāyajivapāṇṇavaṇā, 40, p. 17.
3. "Gūḍhachirāgām pattani sacchirām jaṁ ca hoti ḥicchirām /", Paṇṇavāna, Vanaspatikāyajivapāṇṇavāna. 54, 84, p. 24.
"Gūḍhasirasamādhipavvām samabhāmgaṁamahirūm (ragām) ca / chinnaruham / sādhāraṇām sarirām," etc., Jivavicāra, 12.
"Gūḍhasirasamādhipavvām samabhāmgaṁamahiruyām ca chinnaruham / Sādhāraṇām sarirām tavviliyām ca patteyām /", Gommaṭasāra (Jiva., v. 187).
4. "Mūlam syāt bhūmisambaddham tatra kandāl samāśritāḥ / Tatra skandha iti mitho bijāntāḥ syuryutāḥ same ///" Lokaprakāśa I. 5.107.
5. Ibid.
6. Bhagavatī Sūtra, 7.275.; "Te Jivā tasim ḥānāvīhajoṇiyāḥām puḍhavīnām sinehamāhāremī /" Sūtrakṛtāṅga II, 3, 43.; "Mūlam syāt bhūmisambaddham tatra kandāl samāśritāḥ / Tatra skandha iti mitho bijāntāḥ same /", v. 107. Atah prthvīgatarasamāharanti same, apyami / Yāvat phalāni puḍpastham bijāni phalasāṇgataṁ ", v. 108. Lokaprakāśa I, 5.107-108.

the soil and the conduction of these substances to the stem (*khamdhā*).⁷ In some plants, for example, *āluka*⁸ (sweet patato), *mūlaka* (radish), etc., the roots⁹ have still another function as storage places for large quantities of food.

The Environment of Roots : Soil

The soil (*pr̥thivikāya*)¹⁰ provides a solid, yet penetrable foundation in which plants can anchor themselves and also serves as a reservoir for the water and minerals¹¹ needed by plants for their growth. The soil is another major ecosystem containing a large number of different kinds of animals, bacteria and plants¹² that comprise an interrelated biologic complex.

The Stem and its Functions

The stem¹³ which in a tree includes trunk, branches and twigs¹⁴ is the connecting link between the roots, where water and minerals enter the plant, and the leaves,¹⁵ which manufacture food. The Vascular tissues of the stem are continuous¹⁶ with those of root and leaf and provide a pathway for the exchange of material. The stem and its branches support the leaves so that each leaf is exposed to as much sunlight as possible. Stems also support flowers and fruits¹⁷ in proper position for reproduction to occur. The stem¹⁸ is the source of all leaves

7. Ibid ; Lokaprakāśa I, 5.107-108.
8. “ Ālue mūlæ ca, sīṅgabere taheva ya /”, Uttarādhyayana Sūtra, 36-96.; Gommaṭasāra (Comm.), v. 186, Jivakāṇḍa (ginger, termeric, etc. are roots).
9. Ibid.; Utpala, etc. are born of roots, which function as storage places. See Lokaprakāśa, 5.151; Uttarādhyayana, 36.95. Bhagavatī, 9.33.385; 11-(1-8)-116; Paññavaṇā, 51 (Se kīm jalaruha).
10. “ Puḍhavijoniya puḍhavisaṁbhavāpuḍhavisu rukkhattāe viuttaṁti /”, Sūtrakṛtāṅga, II. 3.43.; Lokaprakāśa, 5.107-108.
11. “ Te jīvā tesīm nānāvihajoniyānam siñchamāhāreṁti / te jīvā āhāreṁti puḍhavīṇām teusarīraṁ vāusarīraṁ vanassaisarīraṁ /” Sūtrakṛtāṅga II, 3.43; Lokaprakāśa 5.107-8.
12. Sūtrakṛtāṅga II. 3.
13. “ Kāmīdattāe khamdhattāe tayattāe sālattāe pavālattāe /” Sūtrakṛtāṅga II. 3.46. “ Mūle kāmde khamdhē taya ya sāle pavālapatte ya / pupphe palabje viya patteyam jīvaṭhānām //”, vide Lokaprakāśa, 5.77.; Paññavaṇā, 41, pp. 17-18.; “ Mūlakanda - skandha - patrādi gatajīva saṅkhyāpramāṇāni ca ”, Gommaṭasāra, (Jivakāṇḍa), v. 189,
14. Ibid.
15. Ibid.
16. Ibid.; Bhagavatī, 7.3.275; Lokaprakāśa, 5.107-108.
17. Ibid.
18. Sūtrakṛtāṅga II. 3.43; Bhagavatī. 7.3.275; Paññavaṇā, 41, pp. 17-18; Lokaprakāśa 5.77; 5. 107-108.

and flowers produced by a plant, for its growing points produce primordia of leaves (kisalaya) and flowers (puṣpa). Roots and stems are sometimes confused, for many kinds of stems grow underground¹⁹ and some roots²⁰ grow in the air. Fern and grasses²¹ are examples of plants that have underground stems called rhizome in Botany. These grow just beneath the surface of the ground and give rise to above-ground leaves. Thickened under ground stems,²² adapted for food storage, called tubers in Botany, are found in plants, such as, suraṇakanda, vajrakanda, patato,²³ etc. An onion bulb is an underground stem (kamda)²⁴ surrounded by overlapping tightly packed scale leaves. Roots and stems are structurally quite different. Stems, but not roots have nodes (parva)²⁵ which give rise to leaves. The tip of stem (agra)²⁶ is naked unless it terminate in a bud.

Plant stems are either herbaceous²⁷ or woody.²⁸ The soft, green, rather, thin herbaceous stems are typical of plants called annuals in Botany. Such plants start from seed (bija),²⁹ develop, flower and produce seeds within a single growing season, dying before the following winter. Another type of herbaceous plant is the biennial,³⁰ which has two-seasons' growing cycle. During the first season, while the plant is growing, food

19. “ Savāu Kāmādajāī sūraṇakamdo ya vajjakaṁdo ya / Allalahiddā ya tahā addaṁ taḥa allakaccuro 88 Sattāvavī, Virali kuṇārī taha thohari galo ia / up to Ālū taha piṇḍalū haravarānti..... /”, Vide Lokaprakāśa, 5.88-92; Uttarādhyayana Sūtra 36.97, 98, 99. e. g. Sūraṇa (Arum campanulatum)
20. Adventitious roots of Banian trees which issue from its branches. Gaḍuci's (Gulañca) roots (adventitious) grow in air, Jīvavīcāra, v. 12.
21. Tṛṇa, Uttarādhyayana Sūtra 36.94; Bhagavatī, 21. “ Sediya bhattiya hottiya ḍabbha kuse pavvae ya poḍailā / Ajuṇa asāḍhae rahiyaṁse suaṁ veya khire tuse / Eranḍahe kuruvimde kukkhaḍa sumhe tahā vibhaṅgu ya / Mahurataṇa luṇaya sippiya bodhavve sumkalitaṇā ya // ”, Paṇṇavaṇā. 47.35, 36.
22. Lokaprakāśa, 5.88 62.
23. Uttarādhyayana Sūtra, 36.97-98: Vide Lokaprakāśa, 5.88-9.
24. Ibid., Uttarādhyayana Sūtra, 36.97; Gommaṭasāra, Jīvakāṇḍa, 18, (Comm.) V. 186.
25. Uttarādhyayana Sūtra, 36.95; Parva (node), Paṇṇavaṇā 46, 33-34, p. 19; Gommaṭasāra, v. 186. (Jīvakāṇḍa); Lokaprakāśa, 5.81,98; “ Vṛkṣā Gucchā Gulmā latāscā vallyaśca parvagāścaiva / ” (98).
26. Sūtrakṛtāṅga II. 3.43; Gommaṭasāra, v. 16.6; “ Mūlaggapīrebajā kamda taha khaṁdhabijabīaruhā / Saṁmuccimā ya bhaṇiya patteāḥāntakāyā ya / ” (186) Bhagavatī, 6.7.46; 71.2.691.
27. Rice, etc.; “ Sāli vihī godhūma javajavā kala masūra tilamuggā / Māsa nipphāva kulatha alisamda satiṇā palimāṁtha ” Ayasī Kusumābha Koddava kāmgu rālaga varasāmaga ko ūsā // saṇa sarisava mūlagā bīya jā yāva aṇṇā tahapaggārā // Paṇṇavaṇā. 50, 42.43, pp. 20-21; Lokaprakāśa, 5.54-55. Setpadi
28. Lokaprakāśa, 5.79, 96.
29. Paṇṇavaṇā, 50.42-43; Lokaprakāśa, 5.54-55; Bhagavatī, 6.7.246; 21.2.691.
30. Lokaprakāśa 5 89; Jīvavīcāra 10.

is stored in the root. Then the plant dies and is replaced in the second growing season by a second top which produces seeds. Carrots (*gajjara*)³¹ and *Suraṇakanda*³² are examples of bennials quite different from the herbaceous annuals and bennials are the woody perennials, which live longer than two years and have a thick tough stem³³ or trunk, covered with a layer of cork. A tree is a woody-stemmed perennial that grows some distance above ground before branching and so has a main stem or trunk-curved straight, long, etc.³⁴ A shrub³⁵ is a woody perennial with several stems of roughly equal size above the ground line.

The Leaf and Its Function

The Jainācāryas do not throw much light upon the structure and function of leaf of plant except the following things: The leaf may be endowed with *Kṣīra* (a waxy cutin ?) or may not be so (*niḥkṣīram*) and may have fine veins (*gūḍhaśīram*) and their invisible joints (*parvas*) in between two half parts of it,³⁶ i. e. “ the upper and lower layers of the leaf epidermis filled with thin walled cells, called mesophyll, which are full of chloroplast.”³⁷

Each leaf is a specialized nutritive organ whose function is to carry on photosynthesis.³⁸ Leaves are generally broad and flat to present a maximum surface to sunlight.

Leaves³⁹ originate as a succession of lateral outgrowths called

31. Ibid ; *Jīvavicāra* (3.) Ibid.
32. *Sūtrakṛtāṅga* II. 3; *Uttarādhyayana* *Sūtra*, 36.94 (Comm.); *Paṇṇavaṇā*, 13 15; (*Rukkha*), 41, 16-18; “ *Ankulla jambunimbāmrāḥ*, etc. up to *Sapūpārṇae dadhiparṇa 1*”, etc. *Lokaprakāśa*, 5.100-103; *Paṇṇavaṇā*, 40.13-15.
33. *Lokaprakāśa* 5.40. (*Utkatāl Kāṁṭakaiḥ kecīt*); “ *Yatra skandhakandamulaśākhaśu khalu Viṣyatē / Tvacā sthūlatārā kāṣṭhāt sā tvacānāntajivikā //79//*”; “ *Yatra mūlaskandhakandaśākhaśu dṛṣyate sphuṭām / Tvacā Kaṇiyāśi Kāṣṭhāt sā tvak pratyekajivikā //96//*”, Ibid., 5.79, 96.
34. *Lokaprakāśa*, 5.40.
35. *Uttarādhyayana* *Sūtra*, 36.94; *Gulma* (shrubs). It brings forth twigs or stems instead of stalks. e. g. *Navamalikā* *Josminum* *Śimbac*, *Kanovīra*, etc.
36. “ *Gūḍhachirāgām patrām sacchīram jām ca hoti nicchīram / jām pī ya paṇāṭhasaṁdhīm aṇāmātajivām vivaṇāḥi //*”, *Paṇṇavaṇā*, 54.7.25. “ *Sakṣīram vāpi niḥkṣīram patrām gūḍhaśīraṁ ca yat / Alakṣyamāṇapatrārddhadvayasandhī ca yadbhavet //*”, *Lokaprakāśa*, 5.84.
37. Biology, p. 126,
38. *Bhagavatī* *Sūtra*, 7.3.275.
39. “ *Mulattāepavālattāe pattattāe pupphattāe phalattāe biyattāe viuttāmīti //*”, *Sūtrakṛtāṅga* II. 3.47; “ *Pattā patteyajiviyā //*”, *Paṇṇavaṇā*, 40; “ *Bije ca yonibhūte vyutkramati sāiva Janturaparo va / Mūlasya Yasca kartā sa leva tatprathamapatrasya //*”, *Lokaprakāśa*, 5.61; “ *Sa eva nirvarttayati mūlāṁ patrām tathādīmāṁ / Mūlaprathamapatre ca tata evaikākārke //*”, Ibid. 5.65; “ *Savvo vi kisalao khalu uggamamāṇo anaṁtao bhaṇio //*”, Vide *Lokaprakāśa* 5, p. 361; *Paṇṇavaṇā*, 54.98.

primordia (Kisalaya) from the apical meristem at the tip of the stem (agra). Each outgrowth undergoes cell division, growth and differentiation and finally a miniature, fully formed leaf is produced within the bud (aṅkura).⁴⁰ In Spring and Summer the leaves grow rapidly, forcing apart the bud scales and largely by the absorption of water, unfold, enlarge and reach their full size.⁴¹ Many leaves have no meristematic tissue and thus do not live long.

TRANSPiration

Nothing is clearly stated by the Jainācāryas about transpiration. It may occur in all parts of the plant exposed to the air as it is lomāhā in⁴² but most of it occurs in the leaves according to Botany.⁴³

The suction force⁴⁴ connected with transpiration pull contributes to the economy of the plant by assisting the upward movement of water through the stem by concentrating in the leaves the dilute solutions of minerals absorbed by the roots⁴⁵ and needed for the synthesis of new vital force and by cooling the leaves.

The Movement of Water

The ascent of sap(rasa)⁴⁶ is brought about by the suction force which is connected with transpiration pull and root pressure.⁴⁷ Root pressure is the positive pressure of the sap in the ducts at the junction of root and stem, generated by the hypertonicity of the sap in the roots to the water in the surrounding soil.

In Spring and Summer⁴⁸ before leaves have been formed, root pressure is the sole cause of the rise of sap. Once leaves have developed, the continued ascent of water is brought about largely by the process of the suction force which is connected with transpiration⁴⁹ pull. Modern Biology explains this thing in this way that "the constant evaporation of water from the cells of the leaf and the production of osmotically active substances by photosynthesis combine to keep the leaf cells

40. " Sudgacchan praṭhamāṅkuraḥ /", etc. Lokaprakāśa, 5.74.

41. Bhagavati

42. Bṛhatsaṅgraham, vv. 181, 182, 184.

43. Biology, p. 128.

44. Lokaprakāśa, 5.32, 33, 34.; 5.107, 108.

45. Ibid.

46. Lokaprakāśa, 5.32, 33; 5.107-108.

47. Ibid.

48. Lokaprakāśa, 5.32, 33; 5.107, 108.

49. Biology, p. 128.

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hypertonic to the sap in the veins. They constantly draw water from the upper ends of the Xylem vessels and this tends to lift the column of sap upward in each duct.”⁵⁰

“ Transpiration provides the pull at the top of the column, and the tendency of the water molecules to stick together, carrying this force through the length of the stem and roots, results in the elevation of the whole column of sap.”⁵¹

The Storage of Food

It is stated in the Jaina Āgama⁵² that a green plant consumes more food in particular season (rainy season), while it takes less food in some seasons (winter or autumn, spring and summer). Each plant must therefore accumulate food reserves to tide over periods when photosynthesis cannot occur. Food stores may be deposited in leaves,⁵³ stems⁵⁴ or roots.⁵⁵

Leaves serve as temporary depots for food, but they are not suitable for long-term storage, for they are too easily and too rapidly lost. The stems of woody perennials⁵⁶ serve as storage places for large amounts of food; other plants utilize underground fleshy stems⁵⁷ for the purpose. The most common storage organs are roots,⁵⁸ for, being underground, they are somewhat protected from climatic changes and from the prying eyes of animals. Plants also deposit rich stores of food in their seeds⁵⁹ to provide energy for the development of the embryo until the new plant has developed a functional root, stem and leaf. Such seeds rich in plant food are an important source of food for man and other animals.

50. Biology, p. 128.

51. Ibid., p. 128.

52. Bhagavati Sūtra, 7.3.275.

53. Kumbard, Jivavicāra, V. 12.

54. All Kandas, Surāṇa, etc. bulb, etc. Bhagavati 7.3.276; Vide Lokaprakāśa 5.88; Paññavānā 54.53.

55. Radish, Carrot, etc. – Bhagavati 7.3.276; 8.3.314.

56. Vṛkṣa, mango tree, Bhagavati 21.8.691, etc. Paññavānā, 40.

57. Surāṇa, etc. Bhs. 7.3.276. Paññavānā, 40.

58. Carrot, radish (Bhs. 7.3.276) etc. Jivavicāra 8; Lokaprakāśa 5.89 P. 132.

59. Rice, etc., Bhagavati Sūtra, 6.7.246; Paññavānā, 50, P. 20.

(Fourth Section — A)

Types of Plants

According to Jaina Biology, there are two types of plants, viz. subtle (sūkṣma) and gross (bādara),¹ and both of them are either fully developed (paryāptaka) or undeveloped (a paryāptaka).² The gross and fully developed plants are of two kinds: either many have one body in common (sādhāraṇaśarīra) or each has its own body (pratyekaśarīra).³ Those which severally have their own body (pratyekaśarīra) are of many kinds,⁴ such as, trees, shrubby plants,⁵ shrubs,⁶ big plants,⁷ creeping plants,⁸ grass,⁹ palms,¹⁰ plants of knotty stems or stalks,¹¹ mushrooms,¹² water plants, (jalaruha), annual plants (oṣadhi),¹³ and herbs,¹⁴ etc.

Those plants of which many have one body in common are of many

1. “Duvihā vaṇassaijiva, suhumā bāyarā tahā /”; Uttarādhyayana Sūtra, 36.92. Jivābhigama Sūtra, p. 42; “Vaṇassaikāiyāe duvihā pa. tam.-Suhuma Vaṇassai-Kāiyā ya bāyara-vaṇassai kāiyā ya/”; “Vaṇassaikāiyā duvihā paṇṇattā, tamjaha Suhumavaṇassaikāiyā ya bādaravaṇassatikāiyā ya/”, Paṇṇavaṇā, 1.35., Vaṇassai-kāyajivapāṇṇavanā.
2. “Pājjattamapajjattā evameva duhā puṇā /”, Uttarādhyayana Sūtra, 36.92; Jivābhigama Sūtra, p. 42; Paṇṇavaṇā Sutta, 1.36.
3. “Bāyarā je pājjattā, duvihā te vijāhiyā / Sādhāraṇaśarīra ya, pattega ya taheva ya /” Uttarādhyayana Sūtra 36.93; Jivābhigama Sūtra, p. 421; Paṇṇavaṇā Sūtra, 1.37.
4. “Pattegasarīrā 4, neg. hā te pākittiyā Rukkhā gucchā ya gummā ya, layā vallī taṇā tahā”; Balayā pavvagā Kuhaṇā jalaruhā osahi-tiṇā / Hariyakāya le bodhavvā, pattegai viyahiyyā /” Uttarādhyayana Sūtra, 36.94-95; Jivābhigamā Sūtra, p. 44; Paṇṇavaṇā Sūtra, 1.38.
5. Guccha: it is explained to denote such plants from the single root or bulb of which come forth many stalks, e. g. Vṛṇtāka, Soianum Melongena, Vide S.B.E., Vol. XLV, p. 216, Jacobi.
6. Gulma, similar to the preceding class, but bringing forth twigs or stems, instead of stalks e. g. N. vaṇālikā Jasminum Sambac, Kanavira, etc.
7. Latā, as lorus, Pandanus, etc.
8. Vallī, as gourds piper, betel, etc.
9. Tṛṇa, grass. But of the two examples given in the commentary, Guñjaka is not in our dictionaries, and Arjuna denotes usually a tree, Termanalia Arjuna, Vide S.B.E. XLV, p. 216.
10. Valaya, so-called from their foliation.
11. Parvaga, as sugarcane.
12. Kuhana (bhumipoḍa), plants which cause the earth to burst, as sarpacchatra, mushroom (toad-stool).
13. Seeds, such as rice, etc., annual plants.
14. Haritakāya, such as, tanduleya, etc.

kinds,¹⁵ such as, Āluya¹⁶ (white patato), Mūlaya¹⁷ (radish), ginger,¹⁸ Hārili, Sirili, Sassili, Gāvai, Keyakandali,¹⁹ Onion, garlic, Plaintain tree, Kunduvvaya,²⁰ Lohinthūya, Thihūya, Tohaga, Kāṇha,²¹ Vajjakanda,²² Sūraṇaya,²³ Assakanṇi,²⁴ Sihakannī, Musundhi, Turmeric, etc. and many others like them.²⁵

GROSS PLANTS

Vṛkṣas (Trees)

According to the Jaina Āgamas, there are two kinds of trees, viz. ekāsthikā (single-seeded) and bahubijakā (many-seeded).²⁶

Ekāsthikā is of many kinds, such as, Nimba²⁷ (the Nimb or Neemba tree - Azadirachta Indica), Āmba (Mango tree, Mangifera Indica), Jaṁbu (Black berry tree, Eugenia Jambulabum), Kosām̄ba²⁸ (Kosām̄ra, Schleichera oleosa), Sāla (Sāla tree - Shorea Robusta), Tāla (Palmyra tree), Āmkolla (the plant Alangium - Hexapetalum), Pilu (Salvadoria persica), Selu (Cordia Myx), Šallaki (Boswellia Tharifera or serrala or Mayanahala Pinus Longifolia), Moyai (Mocaki - Moringa ptery gosperma or Šālmali - Bombax Malabarica), Māluya (Mālūra - Aegle Marmelos or Feronia Elephantum), Baula (Bakulo tree - Mimusope Elengi), Palāsa (Butea Frondosa), Karamjā (the tree Pongania glabra), Puttamjīva (Jiyaputā - Roxburghi), (A) Riṭṭha (Sapindus Detergens), Baheḍaga (or Bibhelaka - Terminalia Belerica), Haritaga (Haraḍāe - Terminalia Chebula), Bhallāya (the Acajou or Cashew-nut tree or the marking nut tree).

15. "The Plants in the following list are, according to the commentary, mostly bulbs, well known in the countries where they grow. Many of them are not in our dictionaries. I give the Prākrit form of their names, and note the Sanskrit equivalent when it can be identified."; Jacobi, S.B.E., XLV, p. 216.
16. Āluka, Amorphophallus companulatus.
17. Mūlaka, radish.
18. Uttarādhyayana Sūtra, 36.96.
19. "A various reading has for the last two words (which might be differently divided, āpaikkēikandali. The Kandali, the plantain tree, occurs in the next line again "; Jacobi, S.B.E. XLV, p. 216.
20. A Various reading is Kundambaya, Jacobi, Ibid.
21. Krishnakanda, Nyamrhæa Rubra.
22. Vajrakanda of the Sanskrit Koshas, Jacobi, S.B.E. XLV, p. 217.
23. Sūraṇa, Arum Campāmumatum.
24. Aśvakarṇa is a tree. Vatīka R̄ebusta. Vide S.B.E. XLV, p. 217.
25. Uttarādhyayana Sūtra, 36.99; Paññavaṇā, 1.54, pp. 21-22.
26. Bhagavatī Sūtra, 8.3.324. " Rukkhā duvihā pannattā / Tām̄jahā-egaṭṭhiyā bhubīyā ya / ", Paññavaṇā Sutta, 1.39; Jivābhigama Sūtra, p. 44.
27. Bhagavatī Sūtra, 22.2.692.
28. Nighaṇṭu, Prathama Vṛkṣakanda, V. 123, p. 68, Hemacandra

tree, esp. acid quince for medicine), Umbehariyā (*Ficus glomerata* ?), Khīra (or Khīrini—*Asclepia rosea*, *Mimosakauki* or a Glomerous fig-tree), Dhāyai (*Woodfordia floribund* or *Grishlea Tomentosa*), Piyāla (the tree *Buchanania Latifolia*, in Bengal commonly called Piyāl), Puiya or Puikaramjā (*Caesalpinia Bonducella*), Nivāyaga (*Pongamia glabra*), Seṇahya or Seṇhā (*Slakṣāna*—*Bauhinia Tomentosa* or *Caesalpinia*), Pāsiya²⁹ (a kind of tree), Sisavā (Śimśapā—the tree *Dalbergia sissoo*), Asana (*Terminalia Tomentosa*), Punnāga (Nāgakesar—*Mesua ferrea* or *Roxburghii*), Nāgarukkha (a kind of tree), Sivaṇa (Sivanni= Śīparṇa—*Premna Spinosa* or *Longifolia* or *Omelina arborea*), Asoga (the tree *Jonesia Aśoka*), and besides others like them.³⁰

Their roots, bulbs, stems, barks, branches and twigs are inhabited by innumerable bacteria, their leaves have single bacterius each; their flowers are the habitats of many bacteria and their fruits are single-seeded. For this reason these trees are called Egaṭṭhiyā (*Ekastgikā*)³¹ (monocotolydorous ?).

There are stated to be many kinds of Bahubijaka trees (many-seeded trees), such as, Atthiya (*Asthika*=Guava), Tinduga or Timdu (*Diospyros embryopteris*—Ebony),³² Kavīṭha (Kapīṭha—Koṭhi, many-seeded plant, Feroma Elephantam), Amībāḍaga (Āmrātaka—*Spondias mangifera* or the hog drum tree), Māuliṅga (Mātulūṅga, *Citrus medica*, the citron tree), Billa (Bilva, *Aegle Marmelos*), Āmalaga (*Phyllanthus Emblica*), Phanasa (Jack fruit or bread fruit tree—*Artocarpus Integrifolia*), Dāḍima (the Pomogranate tree, *Punica granatum*), Āsottha or Asattha (Aśattha—*Ficus religiosa*), Umbara (*Udumbara*—*Ficus glomerata*) Vaḍa=Vaṭa (the Banyan tree—*Ficus Bengalensis*), Naggoha (Nyagrodha, *Ficus Bengalensis*), Naṁdirukkha (Nandivṛkṣa, *Ficus retusa*, or Cedrela Toona), Pippali (ri) (Pippal tree, the sacred fig tree, *Ficus Religiosa*), Sayarī (Śatāvari, *Asparagus Racemosus*), Pilukkharukkha (plakṣavṛkṣa—Fig tree—*Ficus Insectoria*), Kāumvariya (Kādumvaria—the opposite leaved fig tree—*Ficus opposite folia*), Kucchumbharika or Kutthumbhari (Kustumbharika—*Coriandrum Sativa*), Devadāli (*Luffa echinata*), Tilaga (Tilaka tree—*Clerodendrum*), Lauya (*Lakuca Artecarpus Lacucha*),

29. Bhagavatī Sūtra, 22.2.692.

30. Bhagavatī Sūtra, 21-1.692 to 22.2.692; Paṇṇavaṇā, 1.40, p. 17; Jivābhigama Sutta, 1.40, p. 17.

31. Bhagavatī Sūtra, 8.3.324; Jivābhigama Sutta, p.45; Paṇṇavaṇā Sutta, I, 40, p. 17.
“Etesi naṁ mūlā vi asaṁkhejjajiviyā, karīdā vi khaṁdhā vi tayā vi sālā vi pavālā vi / pattā patteyajiviyā, pupphā aṇegajiviyā phalā egaṭṭhiyā / settam egaṭṭhiyā /”. (zx) Bhs. 8.3.324; Paṇṇavaṇā 1.45.

32. Bhagavatī Sūtra, 22.3.692; Paṇṇavaṇā, 1.41, p. 17.

Chattoha (Chatrangha – *Pterospermum Suberifolium*), Sirisa (*Sirisa* – *Mimosa sirisa*), Sattavaṇṇa or Sattivavaṇṇa (*Saptaparṇa*, *Alstonia Scholaris*, Seven-leaved tree), Dahivaṇṇa (*Dadhiparṇa*, a kind of many-seeded plant), Loddha (*Symplocos Racemosa*), Dhava (*Anogeissus Latifolia*), Candana (Sandal tree – *Santalum Album*), Ajjuna, Arjuna – the *Terminalia Arjuna*), Niva (*Nipa*), (*Nauclea Kadamba*, or *Anthocephalus Cadamba*) Kuḍuga or Kuḍaya (*Kuṭuja*, *Hotarrhena antidysenteriea* or a kind of tree), Kalamāba or Kayaṁba (*Convolvulus repens* or *Nauclea Cadamba*) and besides others like them.³³

Their roots, bulbs, stems, barks, branches and twigs are asamīkhyā-tajivikā (the habitat of innumerable bacteria); their leaves are pratyeka-jivikā (i. e. each leaf is inhabited by single bacterius; their flowers are inhabited by many bacteria and their fruits are many-seeded. For this reason they are called Bahubijaka.³⁴

Gucchas (Shrubby Plants)

There are stated to be many kinds of Gucchas, such as, Vāṁgani (*Vṛṇtaki* – brinjal),³⁵ Sallai (*Šallaki*, *Boswellia serrata*), Bodai (*Poṭaki* ?, a species of plant), Kacchuri (*Kaccharā* – cow hedge plant, *Mucuna pruriens*), Jāsumaṇā (a species of shrubby plant), Rūbī (*Rūbu* – the castor oil plant, *Ricinus communis*), Āḍhai (Tuber, *Cajanus indicus*), Nili (*Indigofera tinctoria*), Tulsi (*Ocimum sanctum*), Māuliṁgi (*citrus medica*), Katthumbhari (species of shrubby plant), Pippaliya (*piper longum*), Atasi (linseed, *Linum Ultissimum*), Billi (or Billa, *Asa Foetida* ?), Kāyamai (*Kākamāci*, *Solanum nigrum*), cuccu (*Chuñch*, a kind of vegetable plant), Paḍola (*Patola*, *Trichisanthus cucumerina* or *Trichosanthes Dioeca*), Kāṁdali (*Crinum diffusum*), Bāuccā (*Bākuci*, *Psoralia corylifolia*), Vatthula (a fibrous green plant), Badara (*Bora*, *Zyziphus jujuba*), Pattaura (*Pattura Amaranthus Paniculatus* or *Achyranthes Triandra*), Siyauraya (*Setura* ?, Mulberries – *Morus Indica*), Javasaya (the China rose plant or *Hibiscus* plant or *Hibiscus rosa pinensis*), Niggumṇdi (*Nirguṇḍi*, *Vitex negundo*), Akka (*Arka*, the plant *calotropis Gigantea*), Tūvari (*Cajanus Sativa*), Āḍhai (*Cajanus Indicus*), Talaūḍa (*Talakoṭa*, a shrubby plant), Saṇa (*Sāṇa*, *Crotalaria Juneda*), Vāṇā (*Vāṇīra* ?, *Salix tetrasperma* ?), Kāsā (*Sachharum spontaneum*), Maddaga (a kind of shrubby plant), Agaghāḍaga (a kind of shrubby plant), Sāma

33. Bhagavati Sūtra, 22.3.692; Jivābhigama Sutta, pp. 45-46; Pañnavanā Sutta, I. 41, pp. 17.

34. Bhagavati Sūtra, 8.3.324; Jivābhigama Sutta, p. 45; Pañnavanā Sutta, I. 1.41, pp. 17-18.

35. Bhagavati Sūtra, 24.4.692.

(*Panicum* species), *Sinduvāra* (*Vitex trifolia*, five-leaved chaste or tree), *Karamaddae* (*Karamardaka*—*Carissa Carandus*), *Addarūsaga* (a kind of shrubby plant), *Karīra* (*Capparis asphylla*), *Eraवा* (a kind of shrubby plant), *Mahittha* (a kind of shrubby plant), *Jāulaga* (a kind of shrubby plant), *Māla* (*Mālati*, *Jasminum grandiflorum*), *Parili* (a kind of shrubby plant), *Gayamārini* (a kind of shrubby plant), *Kucca* (a kind of shrubby plant), *Kāriyā* (a kind of shrubby plant), *Bhamdī* (*Rubia cordifolia*), *Jāvai* (a kind of shrubby plant—*Jasminum grandiflorum*), *Keyāi* (*Ketaki*, the tree *Pandanus Odorativimus*), *Gāmja* (*Gunja*—*Abrus precatorius*), *Pāḍala* (*Steriospermum Chelonoides*), *Dāsi* (*Barleria cristata*), *Amkolla* (*Alangium Salvifolium* Syn, *Alangrum Lamarku*) and besides others like them.³⁶

G U L M A S (Shrubs)

Gulmas are of many kinds, such as, *Seriya* (*Saireyaka*, *Barleria grandiflora*, *prionitis*), *Nomāliya* (*Navamālikā*, *Jasminum Sambac* ?), *Koramṭaya* (*Barleria prionitis* species), *Bandhujīvaga* (*Pentapetes phoenicea*), *Manojja* (a kind of shrub), *Piyya* (*Curcuma Aromatic*), *Pāna* (the betel plant), *Kanaira* (a kind of gulma), *Kujjaya* (*Rosa moschata*), *Sinduvīra* (*Vitex trifolia*), *Jāi* (*Jāti* *Jasminum auriculatum*), *Moggara* (*Jasminum* species), *Juhiya* (*Yūthikā* *Jasminum auriculatum*), *Malliyā* (*Mallikā*, *Jasminum Sambac*), *Vāsantī* (*Hepatag bengalensis*), *Vatthula* (a kind of shrub), *Kacchula* (*Longzedoary*, *Curcuma Zedoaria* ?), *Sevāla* (*Śaivāla*—*Ceratophyllum demersum*—*Śaivāla* plants), *Gāmthi* (*Granthila* ? a kind of gulma), *Magadantiya* (a kind of Gulma), *Campagaiāti* (*Campakajāti*, *plumeria* or *Michelia Campaka*), *Navaniya* (a kind of Gulma), *Kunda* (a kind of *Jasmine*—*Jasminum multiflorum* or *pubescens*), *Mahājāti* (*Gaertnera Racemosa*) and besides others like them.³⁷

L A T Ā (Vines or Creepers)

There are many kinds of vines, such as *Padmalatā* (a kind of lotus plant—*Lotus Nelumbo nucifera*), *Nāgalatā* (a kind of creeper, *Piper Betle* or *Betel*), *Asogacampakalatā* (a kind of creeper), *Cūtalatā* (a kind of creeper), *Vanalatā* (a kind of creeper), *Vāsantilatā* (a kind of creeper), *Atimuktakalatā* (*Madhavitata*, *Hiptage Bengalensis*), *Kundalatā* (a kind of creeper), *Sāmalatā* (a creeper) and others like them.³⁸ It seems the creeps of different species of flower plants.

36. *Pannavaṇā*, I, 42, p. 18.

37. *Pannavaṇā Sutta*, 1.43, p. 19.

38. *Pannavaṇā Sutta*, I, 45, p. 19.

VALLI (Creeping Plants)

There are many kinds of Vallis, such as, Pūsaphali (a kind of creeping plant), Pūsha (a kind of creeping plant), Tumbi (Bottle Gourd – *Lagenaria Vulgaris*), Tausī (*Trapusa, Cucumis sativus*), Paḍala (Paṭolā, *Trichisanthus cucumerina*), Pañcaguliyā (Pañcangulika *Ricinus communis* which has 5 – lobed leaves), Nāliyā (Nālikā, Indivari latāyam nadīsāke (nālukā or Nalitā, *Arum coloeasia*), Kamguyā (Kamguka, *Panicum miliaceum*), Kadduiyā (a kind of creeping plant), Kakkoḍai (Kākaḍī, Cucumber, *Cucumis Sativus*), Kāriyallai (*Momordica Charantia*), Subhagā (a kind of Valli), Kuvadhā (yā) (a kind of Valli), Vāgali = Vāgulipaṭi (*Buchanania Latifolia* ?), Pāvavallī (a kind of Valli), Atimuttaya (Mādhavilatā, *Hiptage madablota*), Nāgalatā (A kind of Valli), Kaṇha (*Piperaceae – Piper longum*), Suravalli (*Rollerea Tinctoria* ?), Sanghaṭta (a kind of Valli), Jāsuvāṇa (a kind of Valli), Kuvimdevallī (a kind of Valli), Muddiya (Mṛdvikā ? Munakkā, *Vitis Vinifera*), Appā (a kind of Valli, the red lotus type), Bhallī (*Semecarpus Anacardium*), Chiravirāli (*Ipomoea digitala* = Kṣiravidārī ?), Jiyanti = Jivanti (*Leptodania reticuta*), Govāli (*Gopavali* Gopa plant, *Sansevieria Roxburghiana*), Pāni (a kind of Valli), Māsāvalī (a kind of Valli), Guñjavallī (*Abrus Precatorius*), Vacchāṇi (a kind of Valli), Sasbindu (a kind of Valli), Gottaphusiya (a kind of Valli), Girikāṇḍai (Girikāṇḍika = *Clitoria ternatea*), Māluyā Mālurā (a kind of sweet patato plant or *Aegle Marmelos*), Amjaṇai (a kind of Valli, *Hardwickia pinnata*), Daha – Phullai (a kind of Valli), Kāgani (a kind of Valli), Mogali (hedge, a kind of Valli), Akkaboindi (a kind of Valli) and besides others like them.³⁹

PARVAGAS (Knotty Plants)

There are many kinds of Parvagas, such as, Ikkhu (Ikṣu, Sugarcane, *Saccharum Officinarum*), Ikkhuvāḍi (Ikṣuvāṭika, *saccharum officinarum* – the common yellow cane), Vīraṇa (*Andro-pogon Muricatus*), Ekkāḍa (*Sesbania aculeata*), Bhaṁasa (a kind of knotty plant), Sara (Šara, *Eragrostis cynosuroides*), Vetta (cane, *calamus Rotang* or *Fasciculatus*), Timira (Tavariya, a kind of Parvaga), Sataporga (Šataporaka, a kind of Sugar cane), Nala (*Amphidonax* – Karka 8–12 feet high or *phragmites Karka*), Vāṁśa (Vāṁśa, bamboo cane, *Bambus, araudinacea*), Velu (Venu ? *Dendrocalamus strictus*), Kanaka (a kind of Bamboo or Dhamtūro), Kāṁkavāṁśa (a kind of Bamboo), Cāvavāṁśa (Cāpāvāṁśa, a kind of Bamboo), Udaka (a kind of knotty plant), Kuḍaka (a kind of Bamboo, Kuḍā Vāṁśa found in Bangladeśa), Vimaka (Vimacāmīḍā, probably it

39. Pannavaṇaṇa Sutta, I, 45, p. 19.

is *Andropogon acicubilus*), *Kamḍāvelu* (a kind of knotty plant), *Kallāna* (a kind of knotty plant), and others like them.⁴⁰

Trṇas (grasses) :

Trṇas (grasses) are of many kinds, such as, *Seḍiya* (a kind of grass – *Cassia Jona*), *Bhattiya* (a kind of grass), *Hottiya* (a kind of grass), *Darbha* (a kind of grass – *Eragrostis cynosuroides*), *Kusa* (*Kuśa* grass – *Poa cynosuroides*), *Pavvana* (a species of pot-herb), *Poḍāilā* (*Phragmitēs Karka* or a species of reed – *Saccharum Spontanum*), *Ajjuṇa* (*Arjuna* – a kind of grass, *Teṣmanalia tomentosa* ?), *Asāḍhaka* (a kind of grass), *Rohiyamīṣa* (a kind of grass, *Cymbopogon Schoenanthus*), *Suya* (*Sūṣā* ?, *Cassia orientalis*), *Veya* (*Calamus Rotang* ?), *Khira* (a kind of grass), *Tusa* (*Termanalia Bellerica*), *Eraṇḍa* (*Ricinus communis*), *Kuruvinda* (*Cyperus rotundus Linn*, nut grass), *Kakkhaḍa* *Sunṭha* (a kind of grass), *Vibhaṅgu*, (a kind of grass), *Mahurataṇa* (a kind of grass), *Lunaya* (*Portulacaea oleracea* līm), *Sippiya* (a kind of grass), *Sumkalitṛṇa*⁴¹ (a kind of grass), and others like them.

VALAYAS (palms) :

There are many kind of Valayas, such as, *Tāla* (*Palmyra tree*), *Tamāla* (*Tamāla* tree, *Cinnamomum Tamāla*), *Takkali* (*Pictorius* or *Premna integrifolia* or *Pigmenta acris*), *Teyali* (*Tetali* = a species of palm), *Sāra* (a kind of Palm), *Sārakallāṇa* (a kind of *Palma*), *Sarala* (a species of pine, *Pinus longifoila*), *Jāvati* (a kind of *Palma*), *Keyai* (*Pandanus odoratissimus*), *Dhammarukkha* or *Cammarukkha* (a kind of Palm or the Parchment tree), *Bhūyarukkha* (*Bhurjavṛkṣa* ?), *Betula utilis*, a kind of Palm), *Hingurukkha* (*Ferula alliacea*, *Asafoetida*), *Lavaṅgarukkha* (*Lavanga tree*, *Caryophyllus aromaticus*, the clove tree), *Pūyaphali* (*Pūgaphali*, the areca nut tree, *Araca catechu*, Betel nut palm), *Khajjuri* (the date tree, Date Palm, *Phoenix Sylvestris*), *Nālieri* (*Cocoanut tree*),⁴² and besides others like them.

HARIYA⁴³ (Harita, Herbs) :

There are many kinds of herbs, such as, *Ajjuṛuha* (*Divyauṣadhi*, a kind of herb), *Voḍāna* (a kind of herb), *Haritaga* (a kind of green herb), *Taṇḍulejjaga* (*Tanduliyaka*, *Amarantus Polygamous*), *Taṇa* (any

40. Ibid., I. 46, p. 19.

41. *Pañṇavāṇī Sutta*, I, 47, p. 20; *Bhagavatī Sūtra*, 21.6.691.

42. *Bhagavatī Sūtra*, 8.3.324; 21.6.691; 22.1.692.

43. *Pañṇavāṇī*, I.48, p. 20.

gramineous plant, a kind of herb), Vattthula (a fibrous green plant, a kind of herb, *Vāstuka Chenopodium album* ?), Pāraga (a kind of herb), Majjāra (*Plumbago Rosea* or *Termanalia Katappa*), Pāi (a kind of herb), Billi (a kind of herb), Pālakkā (*Spinacea oleracia*), Dagapipali (a kind of herb), Davvi (*Darvi*, *Berberis asiatica Roxb*), Sotthiyasaka (a kind of herb), Maṇḍukki (*Brāhmī*, Thyme leaved cratiola or *Hydrocotyle asiatica*), Mūlaga (*Raphanus Sativus*), Sarisava (Mustard, *Brassica* species), Ambilasāka (a kind of herb), Jiyamātaka (*Jivantaka*, a parasitical plant, a kind of pot-herb, *Cocculus Cordifolius*), Tulsī (*Ocimum Sanctum*), Kanha (*Kṛṣṇa* ? - Black pepper ?), Urāla (a kind of herb), Phanijja (*Phanijjaka ocimum Basilicum*), Ajjaka (*Arjaka*, *orthocyphon palidus*), Bhūnaka (a kind of herb), Coraga (*Anegelica glanca*), Damanaga (*Damanaka*, *Artemisia Sieversiana*), Maruyaga (*Marubaka*, Sweet marjoram, *Origamum marjoram* or *Ocimum Basilicum*), Sayapupphi (*Peucedanum graveolens* or *Crotalaria Spectabilis*), Indivaar (a kind of herb), and others like them.⁴⁴

OSAHI (Annual plants) :

There are many kinds of Osahi (annual plant) such as, Bāli (*oryza Sativa*), Vihi (a kind of rice) Godhūma (Wheat), Javajavā (a kind of barley), Hordeum Vulgarae (a kind of barely), Kalāya (a kind of pulse - *Lathyrus sativa*), Masura (Lentil), Tila (*Sesamum*), Mugga (*Phaseolus*, *Mungo*), Māsa (a kind of pulse, *Phasecolus radiatus*), Nipphāva⁴⁵ (*Rājaśimbi*, *Dolichos lablab*), Kuṭattha (*Kulthi*, *Dolichos uniflora*), Alisāmida⁴⁶ (*Cabalaka prakārāḥ*, *Vigna Catnaga*, *Varbati*), Satīna (*Vaṭaṇa Tubaṭcane*, a kind of peaze, *Pisum Arvense*), Palimamtha (*Matar*, *Vṛttacanaka*, a kind of annual plant), Ayasi (Linseed, *bhangi*, *Linum usitatissimum*), Kusumbha (*Laṭṭa*, *Carthamus tinctorious*), Koddava (*Kodrava*, *Paspalum Scrobiculatum*), Kaṅgu (Millet, a kind of parric seed, *Panicum miliaceum*), Ralaga (*Kanguviṣeṣa*, a kind of annual plant), Varasāmaga (*Varaṭṭa*, a kind of annual plant), Kadūsā or Kadusaga⁴⁷ (*Kodraviṣeṣa*, a kind of annual plant), Śana (flax), Sarisava (Mustard), Mūlaga (radish), Biyaka (*Pteroearpus*, *marsupium*) and others like them.⁴⁸

44. Paṇṇavaṇā, 1.49, p. 20.

45. Nipphāva is also called valla. See Bṛhatkalpa Sūtra Bhāṣya, 5.6049. According to Jacobi, it is *Dolichos Senesis* (Jain Sūtras XLV, p. 374).

46. According to Weter, Alisāmida was a grain imported from Alexandria after the name of which it is called Alisāmida, See Indian Antiquary, Vol. XIX, Jaina Section.

47. The Mahābhārata, refers to Karadusaka as best corn (Mbh. III. 193.19).

48. Paṇṇavaṇā Sutta, I. 50, pp. 20-21; See Bhagavatī Sūtra 6.7.249; 21.2.693.

JALARUHA (Water-plants or Aquatic plants) :

There are many kinds of Jalaruhas (water plants), such as, Uduka (a kind of lotus), Avakā (a grassy plant growing in marshy land, Blyxa, Octandra), Panaga (a kind of fungus born in water), Sevāla (algae), Kalambuyā (Kalambuka, Convolvulus repens, or Ipomaea aquatica), Hoḍha (Haṭha ? Jalakumbhika), the westerlattice, (Pisti Stratiotes), Kaccha (Kakṣā, a kind of water-plant, Termanalia Bellericia ?), Bhāni (a kind of water-plant), Utpala (Lotus, Nymphaea Caerulea), Padma (a kind of lotus), Kumuda (Water lily, Nelumbium Speciosum), Nalina (Water-Lily - Nelumbium Speciosum species), Subhaga (a kind of water-plant, Glycine Debilis, Cyperus Rotundus), Sugandhika (a kind of blue or white water-lily), Poṇḍarika (a variety of lotus, white lotus), Mahāpoṇḍarika (a variety of lotus, of large size), Sayapatta (Śatapatra, a kind of lotus having hundred petals), Sahassapatta (a kind of lotus having thousand petals), Kalhāra (red lotus), Kokanada (a kind of red lotus), Aravinda (a kind of lotus), Tāmarasa (a kind of lotus), Bhīsa (a kind of water-plant), Bhīsamūḍāla (a kind of water-plant), Pokkhala (Puṣkala or Puskara, a kind of lotus), Pokkhalaṭṭhibhae (a kind of lotus), and others like them.⁴⁹

KUHANS (Plants which cause the earth to burst)⁵⁰ :

There are many kinds of Kuhana, such as, Āya (a kind of Kuhana), Kāya (a kind of Kuhana), Kuhana (mushroom-Toad-stool), Kunakka (a kind of Kuhana), Davvahaliya (a kind of Kuhana, Darvaharidra ?), Sapphāka (a kind of Kuhana), Sajjaka (a kind of Kuhana, Shorea robusta ?), Sittāka (a kind of Kuhana), Vāṁsi (a kind of Kuhana, Bambusa araudinacea ?), Nahiya (a kind of Kuhana), Kuraka (a kind of Kuhana) and besides others like them.⁵¹

The above mentioned plants severally have their own respective bodies (pratyekaśarira).⁵²

Trees are of various shapes (nānāvihasamīṭhāṇa); their leaves are ekajivikā (i. e. each leaf has got one soul); the stems (Skandhas) of palmyra tree (Tāla), Pinus longifolia (Sarala) and cocoanut tree (Nālieri) are also inhabited by one soul in each.⁵³ Just as the vatti (light or lamp) made of mustard seeds mixed with sticky thing exists, just so, the collection or combination of the bodies of pratyekaśarira-

49. Paññavāṇā Sutta, 1.51, p. 21.

50. e. g. Sarpachatra, mushroom (toad-stool).

51. Paññavāṇā Sutta, 1.52, p. 2; Jivābhigama Sutta, p. 46.

52. Ibid.

53. “ Nānāvihasamīṭhāṇa rukkhāṇām egajiviyā patta / Khamdho vi egajivo tāla-sarala - nālieriṇām //44// ”, Paññavāṇā 1.53, p. 21; Jivābhigama Sutta, p. 46.

jivas exists.⁵⁴ Or just as Tilapāpḍis (Sesamum Cakes) made of many tilas (grains of Sesamum seeds), exist, just so the collection (or combination) of the bodies of pratyekaśatirajivas remain⁵⁵ together.

Plants have also been grouped into three types on the basis of the number of beings or bacteria existing in their respective bodies, viz. Saṁkhyātajivika (the plant in which there live countable bacteria), Asaṁkhyātajivikā (the plant in which (there) reside innumerable bacteria) and Anantajivikā (the plant in which (there) live infinite bacteria).⁵⁶ Under the first type there come the following plants, viz. Tāla (palmyra tree) up to Nālieri (cocoanut tree), while under the second type (asaṁkhyātajivikā) there are two kinds of plant, viz. ekasthikā (one seeded plant) and bahubijaka (many-seeded plant), e. g. Nimba, Āmra, etc. are one-seeded, while Asthika (guava), Tinduka (Diospyrosembr-yoteris), Dāḍima (Pomogranate), etc. fall under the second variety (bahubijaka).⁵⁷ The third natural order (anantajivikā) consists of the following plants, viz. Āluka (white Patato), Mūlaka (radish), Singavera (ginger), upto Musuṇḍhi and others like them. This classification of plants is scientifically sound when considered in the light of modern Biology.⁵⁸

SĀDHĀRĀNAŚARĪRAVĀDARAVANASPATIKĀYIKAS (Gross plant bodies beings having Common body)

There are stated to be many kinds of Sādhāraṇaśarīrabādaravanaspatikāyikas, such as, Avakā (a kind of grassy plant growing in marshy sand, *Blyxa*. *Octandra* Rich), otherwise, called Śaivāla), Panaga (Panaka-fungus or a kind of Arum), Sevāla (Śaivala = algae), Lohiṇī (Rohiṇī = Soyida febrifuga ?), Mihū (a kind of medicinal plant), Thihū (a kind of plant), Asakaṇṇī (Aśvakarnī = *Dipterocarpus* or the tree *Vatica Robusta*), Sihakaṇṇī (Siṁhakarnī = a kind of plant), Siumdhi (Siṁsumḍhi = a kind of plant, the shrub *Arbus pricatorius*), Musuṇḍhi (a kind of plant), Ruru (a species of fruit tree), Kāṇḍuriyā (Kūṇḍarika = a kind of plant), Jārū (a kind of plant or *Jiru Cuminum cyminum*), Chiravirālī (a kind of plant, Kṣiravidārikā, having kanda, *Ipomaea digitata*?), Kiṭṭhiyā (Kiṭṭi = a kind of plant), Haliddā (Haridrā = curcuma longa), Śringavera (ādu = ginger), Āluga (Baṭaṭa = patatoo), Mulaga (Mūlā, radish), Kambu (Kambuyā = a kind of plant), Kaṇhakadbū

54. “ तः बहा सगलसरिवानाम् सिलेसमिस्साम् वृत्तिया वृत्तिः / पत्तेयसरिरानाम् ताहा होन्ति सरिरसामिंघाया //45//”, *Pāṇṇavāṇā*, I.53.45.

55. “ जाहा वा तिलपाप्पात्याभुच्छिं तिले साम्हिता साम्ति / Patteyasaśirāनाम् ताहा होन्ति सरिरसामिंघाया //46//”, *Ibid.*, I. 53.46, p. 21

56. Bhagavati Sūtra, 8.3.324.

57. *Ibid.*

58. *Ibid.*, 7.3.276; 8.3.324.

(Kannukkaḍa = a kind of plant), Mahuo (Madhuka ? = *Glycorrhiza glabra*), Valaī (a kind of plant), Mahusimgi (Madhuśringi=a kind of plant), Niruha (Niruhā=a kind of plant), Sappasuyamdhā (*Sarpasugamdhā*, the ichenumon plant), Chinnaruhā (Galo=Clerodendrum phlomoides), Biyaruhā (Bijaruha=a kind of plant growing from seed), Pāḍha (pāṭha=*Cyclea peltata*), Miyavālumkī (Mṛgavālumkī=a kind of plant), Mahurarasa (Madhurarasa, a species of *Glycorrhiza glabra*), Rāyavalli (Rājavallī=Paedaria foetida or *Momordica Charantion*), Paumā + Padmā=Bhāramgi=a kind of lotus), Māḍhari (Mādhuri ? = *Foeniculum Vulgarae*), Daṁṭi (*Baliospermum montanum*), Caṁḍi (a species of plant), Kiṭṭi (Kiṭṭhi=a species of plant), Māsapāṇṇī (Māsapāṇṇī=Jaṅgli Adada *Glycine Debilis*), Muggapāṇṇī (Mudgapāṇṇī = *Phaseolus Trilobus*); Jivya (Jivika or Jivaka = the plant Jivantī, or a species of *Pterocarpus marsupium*), Rasabheya (R̥śabhaka=a kind of plant), Reṇuyā (Reṇukā=Vi̥ex agnus-castus), Kāoli (Kākoli=Aśvagāṁdhā = the plant physalis *Flexuosa*), Khirakakoli (a kind of plant), Bhamgi (*Cannabis Sativa*), Nahī (a kind of plant), Kimirāsi (Kṛmirāśi =a species of plant), Bhaddamutthā (Bhadramustā=Motha, a kind of *Cyperus tuberosus*), Naṁgalai (Laṁgalai=The Glory lily= *Gloriosa Superba*), Paluga (Pelugā=a kind of plant), Kīnha (Kṛṣṇa=a king of plant, Black pepper plant ?), Paula (a kind of plant), Haḍha (Hath=Jalakumbhikā, a kind of plant), Harataṇuyā (Haratanukā=a kind of plant), Kaṇha (Kṛṣṇakanda, the lotus= *Nymphaea rubra*), Vajja (Vajrakanda=a species of bulbous plant), Suraṇḍkanda (*Amorphophallus Campanulatus*), Khalluḍa (Khaltura=a kind of plant) and others like them. They are anantajivikā (inhabited by infinite bacteria).⁵⁹

Tṛṇamūla (root of grass), Kandamūla (root of bulb or tuberous root), Vamśamūla (root of bamboo) are inhabited by numerable, innumerable and infinite bacteria.

The Guccha (shrubs or fibrous root) of Siṁghāḍaga (Sṛṅgāṭaka = *Trapa bispinosa*), is the habitat of many bacteria, its leaves are inhabited by individual bacterius in each leaf, while its fruits are inhabited by two bacteria in each fruit.⁶⁰

There are infinite bacteria residing in the root, bulb, stem, bark, branch, twig, leaf, flower, fruit, and seed of the plant or plants which break clean (Samabhaṅga)⁶¹ in equal part.

59. Paṇṇavāṇa Sutta, I. 54, 1, 47-53.

60. Ibid., I. 54-2, 54-55.

61. “Jassa mūlassa bhaggassa samo bhamgo padisae / up to Jassa bīyassa bhaggassa samo bhamgo padisā / aṇantajīve u se bie, je yāva aṇne tahāvihā //5//”, Ibid., I. 54.3, vv. 56-65.

There is the presence of limited bacteria (or single bacterius) in the roots, bulbs, stems, bark, branches, twigs, leaves, flowers, fruits and seeds of the plants which show thread (fiber) inside, when broken into parts.⁶²

If the bark of any root, bulb, stem and branch of a plant covering the wood of these parts is thicker than the wood, then it is inhabited by infinite bacteria.⁶³ If the bark of any root, bulb, stem and branch of a plant is thinner than the wood of these parts, then it is inhabited by parittajivas (limited bacteria of individual or single bacterius).⁶⁴

If the circular joint of a plant, when broken, is found to be full of much powder like things just as that of dried up earth, it is inhabited by infinite bacteria.⁶⁵

If the leaf of a plant has unexposed veins of leaf branch, waxy cutin or milky substance (Kṣirāṁ) or no waxy cutin (nīlkṣirām) and imperceptible joints of leaf branch, it is endowed with infinite bacteria.⁶⁶

Flowers – aquatic and terrestrial (Jalaja and sthalaja) connected with stalk and hollow stalk (or tube) (Vṛṇtabaddha and nālabaddha) are inhabited by numerable, innumerable and infinite bacteria.⁶⁷

Flowers which are connected with stalk (nālika) are resided by numerable bacteria. Euphorbia nivulia (Nihuya⁶⁸ = sahipuṣpa) are inhabited by infinite bacteria up to those like them also. The bulbs of Padma and Utpala (species of lotus), Antarakanda (that of Antarapuṣpa)

62. “Jassa mūlassa bhaṅgassa hiro bhainge padisai / parittajive u se mūle, je yāva aṇne tahāvihā / up to jassa bīyassa bhaggassa hiro bhainge padisai / parittajive u se bīe, je yāva aṇne tahāvihā //75//”, Ibid., 1.54, 66.75.
63. “ Jassa mūlassa kāṭhāo challī bahalatārī bhave / Aṇamītajivā u sā challī, ja yāva, aṇṇā tahāvihā //76// up to jīse sālāe kāṭhāo challī bahulatārī bhave / Aṇamītajivā u sā challī, ja yāva, aṇṇā tahāvihā //79//”, Paññavaṇā I. 54, 5, 76–79.; See Gommaṭasāra, Jivakāṇḍa, v. 189, p. 117.
64. “ Jassa mūlassa kāṭhāo challī tāṇuyatarī bhave / Parittajivā u sā challī, ja yāva aṇṇā tahāvihā //80// up to jīse sālāe kāṭhāo challī tāṇuyarī bhave / Parittajivā u sā challī, ja yāva, aṇṇā tahāvihā //83//”, Ibid., vv. 80–83; Gommaṭasāra (Jīva.) v. 189, p. 117.
65. “ Cakkāgām bhajjamāṇassa gaṇīṭhī cuṇṇaghaṇo bhave / Puḍhavisarisenā bheyenā aṇamītjivām viyāṇāhi //84//”, Paññavaṇā I, 5¹, 7.84, p. 124.
66. “ Gūḍhachirāga pattaṁ sacchirāmām ca hoti nīcchirām / jaṁ piya paṇṭṭhasaṁdbi aṇamītajivām viyāṇāhi /” Paññavaṇā I, 54, 7, 85.
67. “ Pupphā jalayā thalayā ya veṇṭabaddhā ya nālabaddhā ya / Saṅkhejjamasaṁkhejā bodhavvā aṇamītajivā ya //86//” Ibid., I. 54, 8, 86, p. 24.
68. “ Tnorānā puṣpo ane tenā jēvā bijā puṣpo chhe te anantajivavala hoyā chhe”, Prajñāpanānūvāda, p. 117, Bhagavāṇḍas.; “ Nihuya aṇamītajivā, je yāva aṇne tahāvihā (87), Paññavaṇā Sutta I. 54–8, v. 87.

and like them *Indigofera panchifolia* (*Jhilli*) are the habitats of infinite bacteria, but their stalk and fibre are pervaded by one soul or being.⁶⁹

The bulbs of Onion, garlic, plaintain and *Kusumbaka* (*Kustumbaka* ? *Carthamus tinctorious*) are *parittajivas* (inhabited by limited or individual bacteria) upto those like them.⁷⁰

The stalks (*Vṛṣṭa*), external leaves (*bāhirapatras*), pericarps (*karṇikāś*) of Padma, Nalina, Subhaga, *Sogamīdhikas*, Āravinda, Kokanada, Śatapatra and *Sahasrapatra*⁷¹ are pervaded by one soul (or of one soul in each), while their internal leaves (*abbhimītaraga patta*), the filaments (*Kesara*) and seeds (*mīmījā* = Kamal Kākaḍī) are inhabited by individual soul or being⁷² in each.

The eyes (*acchīm*, i. e. buds), joint (*parva*) and circular ring of the joint (*Balimōḍao* = *parimoṭaka* *parvanu* *pariveṣṭana*) of *Veṇu* *Dendro calamus Strictus*, *Nala* (*Phragmites Karka*), *Ikkhṇvāḍiya* (*Ikṣuvāṭika* = *Saccharum Spontaneum*), *Masamā-Saikkhu* (*Samāsaikṣu* = a kind of Sugarcane), *Ikkāḍa* (*Sesbania aculeata*), *Eranda* (*Rāṇḍa* = *Ricinus communis*), *Karakara* (a kind of plant), *Suṇṭhi* (a kind of ginger), *Vihūṅgu* (a kind of *Vanaspati*) *Taṇa* (*tṛṇa* = grass) and *Parvagas* (trees having joints) are of one soul (or single soul) in each. Their leaves are *pratyekajivikā* (inhabited by individual soul), while their flowers are *anekajivā* (inhabited by many bacteria).⁷³

Pussaphala (a kind of fruit), *Kālīṅga* (*Tarbuca* = *Cucumis Usitatus* or water-melon), *Tuṁba* (the Gourd *Lagenaria vulgaris*), *Trapusa* (*Kākaḍī* = cucumber), *Eelavālu* (*Prunus Cerasus Linn*), *Vāluṇka* (*Vāluka* = a species of *Prunus cerasus*), *Ghoṣṭāṭaka* (*Luffa acutangula* ?), *Paṭola* (*trichosanthus*, *cucumerina*), *Tindoka* (*Diospyros embryopteris*), *Tendusa* (a kind of plant) and their *Viṁṭa* (stalk), *Samāṁsa-kaḍāha* (*Samāṁsa-Kaṭāha* = fleshy part of fruit = ovary and upper skin of the fruit) are of one soul (i. e. pervaded by one soul). Their leaves are *pratyekāṁ* (inhabited by individual bacteria) and also their filamental and non-

69. "Paumuppaliṇīkāmde aṁtarākāmde taheva jhūlli ya / etc. aṇāṁtajivā ego jivo bhisa-muṇḍale" (88), *Ibid.*, v. 88.

70. "Palamālu-lhasaṇa kāmā ya kāṁdali ya Kusūṁbae / Ee parittajivā, je yāva aṇṇe tāhavihā" (89), *Ibid.* v. 89.

71. All are different species of lotus.

72. "Paumuppala halīṇāṁ subhaga-sogamīdhīyāna ya /..... Abbhimītaragā patta patteyāṁ kesarā mīmījā", *Ibid.*, vv. 90-91.

73. *Veṇu* nāla ikkhvāḍiya masamā saikkhu ya ikkāḍeraṁde /..... patteyāṁ pattaṁ pupphāṁ aṇegajivāṁ" II (93), *Ibid.* vv. 92-93.

filamental (sakeśara and akeśara) and seeds (mimja) are resided by individual bacteria in each.⁷⁴

Sapphāya (Sampāka ?, Catharto earpus fistula ?), Sajjae (Sajjhaya = a kind of plant), Uvveheliyā (a kind of Vanaspati), Kuhana (mushroom) and Kanduka (a kind of Vanaspati = betel nut ?) are anaṁtajivā (inhabited by infinite bacteria), while Kandukka may be alternately anaṁtajivā and may be parittajiva or (pratyekajivā) (inhabited by individual bacteria) also.⁷⁵

The plant life (or soul) existing in seed in its dormant stage is born (or manifests itself) in germinating seed or another soul (or life) comes into existence in it. But the soul (or life) which is in the root is also pervading the first leaf (prathama patra) at this stage of the plant's life, all shoots of the plant, being sprouted, are called anantajivā (inhabited by infinite bacteria). That shoot, while growing, becomes parittajiva (inhabited by individual or limited beings or bacteria) or anantajivā (inhabited by infinite bacteria).

There take place simultaneously the birth, formation of bodies, receiving of matter and respiration of Sādhāraṇaśarīrabādaravanaspatikāyikas (bacteria having common body).⁷⁶

That which is the receiving of one of Sādhāraṇaśarīrabādaravanaspatikāyikas is that of many of them. That which is the receiving of many is the receiving of one in short. The common food and the common respiration are the common differentia of these common (group) beings having inclusion-bodies⁷⁸ (Sādhāraṇaśarīra).

Just as the iron ball, when heated in fire, becomes red like heated gold - all got transformed into fire, just so the Nigodajīvas (viruses) which are also sādhāraṇa śarīravanaspatikāyika should be known in

74. Pussaphalam kāliṅgam tumbam tauselavālu vālumkām / Ghosāḍayām Paḍolām Tindūyām ceva Tendūsām (94) Viṁṭa samāṁsa-Kaḍāham eyāim hoṁti egajivassa patteyām pattiām sakesaramakesaram mimjā //” (95). Pañṇavaṇā Sūtra, I. 54. 8, vv. 94-95.

75. “Sapphāe sajjāe uvvehaliyā ya Kuhaṇa Kaṁdukke / Ee aṇaṁtajivā Karṇḍukke hoti bhayaṇāu //” (96), Ibid., v. 96.

76. “Jōṇibbhūe bie jivo vakkamai so va aṇṇo vā / jo vi ya mule jivo so vi ya patte paḍhamaiāe //” (97). “Savvo vi kisalao Khalu uegamamāṇo aṇaṁtao bhaṇio / So ceva vivadḍhamito hoi paritto aṇamte vā //” (98), Ibid., I.54.9, 97-98.

77. “Samayaṁ Vakkamitāṇam samayaṁ tesīm sariranivvatti / Samayaṁ āṇuggabaṇam samavaṁ ūsāsa-nisāse //” (99), Pañṇavaṇā Sūtra, I. 5 10, 99.

78. “Ekkassa u jaṁ gahaṇam bahūṇam sahāraṇāṇatam ceva / Jaṁ bahuyāṇam gahaṇam samāsao tam pi eggassa //” (100), “Sahāraṇamāhāro sahāraṇamānuyāṇāga haṇam ca / Sahāraṇajivāṇam sahāraṇalakkaṇam eyam /” (101), Ibid., vv. 100, 101.

or dry season and germinate only with the advent of the next favourable growing season.⁵² A prolonged period of dormancy usually occurs only in seeds with thick or waxy seed-coats which render them impenetrable to water and oxygen.

The life of some higher plants exists within the cover of seeds in state of dormancy to be awakened at a proper time and season under the favourable conditions. The life persists within the protective seed-coat for certain period, resisting against all the forces of the natural phenomena. In due time and season this dormant life springs up, bursting asunder the seed-coat and begins to grow gradually into a full plant like all beings, though in its immobile state, due to the transformation within itself.⁵³

The length of time that a seed will remain viable and capable of germination varies greatly. The viability of the cereals, such as, Śāli, Brihi, Godhūma (Wheat), etc., if preserved in a well-protected granary, lasts in the minimum for an antarmuhūrta and in the maximum upto three years, that of pulses, such as, Kalāya (a kind of pulse), Masura (lentil), Mung (Phaseolus Mungi), etc., for an antarmuhūrta in the minimum and five years in the maximum and that of Alasi (linseed), Kusumbhaka (Carthamus tinctorious), Kodrava (Paspalum scrobiculatum), Kangri (millet or a kind of paric seed), Śana (flax), Sarṣapa (mustard seed), Mūlaga (radish seed), etc., for an antarmuhūrta in the minimum and seven years in the maximum, provided they are stored up scientifically. After the specified periods their respective viability withers away and the seeds become unseeds without having germinating capacity.⁵⁴

This evidence of Jaina Biology regarding viability of seeds finds support in modern Biology in this way. "Willow and poplar seeds must germinate within a few days of being shed or they will not germinate at all;⁵⁵ seeds of the evening primrose and of yellow dock were able to germinate after seventy years".⁵⁶ There are authentic

52. Bhagavati, 15.1.544. It throws light upon the germination of sesamum seeds with the advent of favourable growing season after the uprooting of the Sesamum-plant by Gośala Mañkhalisutta.

53. Bhagavati Sūtra, 15.1.544; See Plant Autographs and their Revelations, Sir J. C. Bose, 1927.

54. Bhagavati Sūtra 6.7.246.

55. Biology, p. 186.

56. Ibid.

records of lotus seeds germinating 200 years after being shed.⁵⁷ The ability of a seed to retain its germinating power depends on the thickness of the seed-coat, on a low water content, and on the presence of starch rather than fats as stored food material. Dormant seeds are alive and do metabolize, though at a very low rate.⁵⁸

The reference to *Joṇibbhūe bie* (embryonic seed), hypocotyle (first radicle = *mūla*), cotyledons (*prathamapatras*), epicotyle (*prathama Kīśalaya*) and its development of growth (*vivadḍhamāta*), their simultaneous birth, formation of plant body (*samayaṁ vakkamātāṇam samayaṁ tesim̄ sarirāṇivvatti*), receiving of matter (warmth and moisture, etc.) and respiration (*samayaṁ ānugghaṇam samayaṁ ūsāsa-nisāse*)⁵⁹ suggests that germination is initiated by warmth and moisture and requires oxygen. The embryo and endosperm absorb water, swell and rupture the seed-coats (*Uggamamāṇa*).⁶⁰ This frees the embryo and enables it to resume development (*Vivadḍhamta*).

After germination the hypocotyle (*mūla*) elongates and emerges from the seed-coat (*vakkamai*). "The primitive root or radicle grows out of the hypocotyle⁶¹ and since it is strongly and positively geotropic, it grows directly downward into the soil."⁶² "The arching of the hypocotyle in a seed such as the bean pulls the cotyledons (i.e. *prathamapatras*) and epicotyle (*kīśalaya* or *amkura*) out of the seed-coat and the epicotyle, responding negatively, to the pull of gravity grows upward.⁶³ The cotyledons (*prathamapatras*) digest, absorb and store food from the endosperm, while within the seed. The Cotyledons of some plants shrivel and drop off after germination; those of other plants become flat foliage leave. The cotyledons contain reserves of food that supply the growing seedling (*kīśalaya*) until it develops enough chlorophyll to become independent. The stem (*skandha*) and leaves (*patras*) develop from the epicotyle (first *Kīśalaya*).⁶⁴

57. Ibid.

58. Ibid.

59. "Joṇibbhūe bie jivo vakkamai so vā aṇṇo vā / Jo vi mūle jivo so vi ya patta paḍhamatāe" //97// "śavvo vi kīśalayo khalo uggamamāṇo aṇāmītayō bhaui / so ceva vivadḍhamāta hoi paritto aṇāmīt vā /" 98 // "Samayaṁ vakkamātāṇam samayaṁ tesim̄ sarirāṇivvatti / Samayaṁ ānugghaṇam samayaṁ ūsāsa-nisāse //99// Paññavaṇā 1.54, 9-10, 97-9

60. Ibid.

61. Biology. p. 187.

62. Ibid.

63. Biology, p. 187.

64. See above the embryonic development of plant.

Evolutionary Trends in the plant kingdom.

As we glance back over the many types of plant life cycles that are found from algae to angio-sperms, a number of evolutionary trends appear to be evident. One of these is a change from a population that is mostly haploid individuals to one that is a most entirely diploid—an evolutionary trend toward a greater size and importance of the sporophyte⁶⁵ and a reduction in the size of the gametophyle generation.

65. Sūtrākṛtāṅga II. 3.43

THIRD CHAPTER
ANIMALS AND THEIR CLASSIFICATION
(First Section)

Classification of Animals : Lower Invertebrates

INTRODUCTION

To catalogue the vast array of animals the Jainācāryas have used a classification system of animals based upon observation of similarities of structure¹, sense-organs², mode of origin³ and development.⁴ In the study of taxonomy they have differentiated superficial and accidental similarities from the significant fundamental ones. Homologous structures⁵ of various animals (which arise from common rudiments and are similar in basic plan and development) have been distinguished from analogous structures⁶ (which are similar in function). Accordingly the arm of a man, the wing of a bird, the fin of a fish are homologous⁷, with basically similar structural plan and similar

1. E. G. Catuśpadas (quadrupeds) Egakhurā (Solidungular), Dukhurā (Biungular), Gaṇḍipayā (Multiungular), and Saṇapphayā (animals having toes with nails); Parisarpas (reptiles) - Bhujaparisarpas (those which move on arms) and Uraḥparisarpas (those which move on breast); Uttarādhyayana Sūtra 36; 179-181; Paṇṇavāna I. 69, 70; 1-76.; Tattvārthādhigama Sūtra II. 24
2. Bhagavatī, 1.5. 48-49; 2.1. 83-84; 9. 32. 375; 20. 1. 663; 24. 17. 708-712. Uttarādhyayana Sūtra, 36. 177; 136, 150-155, Paṇṇavāna Sutta, 1. 56, 57, 58, 61-91, 92-138. “Kṛmyādināṁ pipilikādināṁ bhramārādināṁ manusyādināṁ ca / yathāsaṅkhyam:kaikavṛddhāni indriyāṇi bhavanti yathākramāṇi / Tad yathā kṛmyādināṁ apādikānūpurakagaṇḍūpada - śaṅkha - śuktika - śambūka - jalukā - prabhṛtiṇāṁ sparsanarasanendriye bhavataḥ I sesānāṁ ca Tiryag-yonijānāṁ matsyoragabhujaṅga - pakṣicatuśpadānāṁ sarveśāṁ ca nārakamanuṣyadevānāṁ pāncendriyāṇi /” Tattvārthādhigama Sūtra, II. 24.
3. Bhagavatī 7.5.282; 9.32.375; Uttarādhyayana Sūtra 36.170; Jīvābhigama Sūtra 1.33. ; Paṇṇavāna Sūtra, 1.56 (Saṁmūcchimā). , , 1.57 (Saṁmūcchimā). , , 1.58 (Saṁmūcchimā). , , 1.68 (Saṁmūchhimā and , , 1.75 Gabbhavukkāntīya). , , 1.84 , , ; Tattvārthādhigama 1.85 , , Sūtra II. 34
4. Ibid.
5. Arms of man, wings of birds, fin of fish are homologous ; Tattvārtha Sūtra II. 34.
6. Wings of bat and bird are analogous structures.
7. Paṇṇavāna I. 92,138 (Manussa) : 1.86 (Khachacara) ; 1.62-63.

embryonic origins⁸. Structure of animals may be both homologous and analogous, e. g. the wings of birds and bats⁹ have a similar structural plan and development, as well as the same function.¹⁰

Because all animals have essentially the same problems to solve in order to survive, there is basic unity of life among them.

The Basis For Animal Classification According to Jaina Biology.

According to Jaina Biology, the main divisions of the animal kingdom, the phyla, are differentiated by basic characteristics which usually are not unique for a single phylum, but occur in unique combinations in various ones. Some factors basic to the determination of an animal classification are as follows :

(a) The presence or absence of cellular differentiation¹¹ and the presence of sense-organs—two to five-sense-organs.¹² Animals may be either single-celled, e. g. *kṛmi*¹³ (the protozoa), or composed of many kinds of cells, specialized to perform particular tasks in the body's economy, e. g. higher animals and man having five sense-organs.¹⁴ In all the higher animals, cells are differentiated and specialized. Besides, animals may be either two-sensed¹⁵ or three to five-sensed.¹⁶

(b) The type of body-symmetry, whether spherical¹⁷, radial¹⁸ or bilateral.¹⁹ Animal bodies may be organized to one of the three types of symmetry.

8. Paññavānā 1.68, 75, 84, 85, 91, 92 ; Tattvārthādhigama sūtra II. 34

9. Wings of Cammapakkhi and Lomapakkhi ; Paññavānā 1.86.

10. Ibid., (Wings of bats and birds have the same function).

11. Most of the two-sensed animals have one-celled body, e.g. *kṛmi* (worm), while five-sensed animals have cellular differentiation;

12. Bhagavatī Sūtra, 1.5. 49²; 2.1. 83-84; 9. 32-375; 20. 1.663; 24.17.108-12. Uttarādhyayana Sūtra 36.127; 136: 150-155 Paññavānā Sūtra, 1.56, 57, 58, 61-91, 92-138. ; Tattvārthādhigama Sūtra II. 24.

13. Uttarādhyayana Sūtra 36.128 ; Paññavānā 1.56 ; Tattvārthādhigama Sūtra II. 24. (Kṛmyādinām, etc.)

14. Pancendriyas ..., Uttarādhyayana Sūtra 36.155; 170, etc. ; Tattvārthādhigama Sūtra II. 24.

15. Uttarādhyigama Sūtra 36.128 ; Paññavānā Sūtra 1.56 ; Tattvārthādhigama Sūtra II. 24.

16. Uttarādhyayana Sūtra 36.155 ; Paññavānā Sūtra. 1.61-91; 1.62.

17. A few of the lowest animals have this type of spherical symmetry.

18. In radial symmetry two sides are distinguishable, a top and a bottom, as in a starfish.

19. Human beings and all higher animals have bilateral symmetry, in which only one special cut will divide the body into two equal halves, e.g. the body of a man has bilateral symmetry anterior and posterior, dorsal and ventral sides.

(c) The number of modes of origin, generation, e. g. Sammūrcchima²⁰ (generatio aequivoca or asexual reproduction) and Garbhavyutkrāntika²¹ (generation from the womb, sexual reproduction)-aṇḍaja (Oviparous generation), Jarāyuja (Viviparous) and potaja (viviparous generation without the placenta).²² {Some of the metazoa (higher animals) have only two embryonic cell layers or germ layers—an outer ectoderm and an entoderm, e. g. jarāujas and potajas.²³

(d) The presence or absence of segmentation.²⁴ The members of several phyla are characterized by the fact that their bodies consist of a row of segments,²⁵ each of which has the same fundamental plan, with or without variation, as the segments in front and behind. In some segmental animals, such as, man and most vertebrates the segmental character of the body is obscured.²⁶ In man the bones of the spinal column—the Vertebrae—are among the few parts of the body till clearly segmented.

(e) Unique features: There are only a few structures that belong exclusively to one phylum of the animal world, e. g. vṛscikas (scorpions)²⁷ alone have sting cells (nematocysts); although many kinds of animals have a nervous system, only the chordates to which man belongs, have a dorsally located, hollow nerve cord.²⁸

In Jaina Biology, animals are also classified according to the environment in which they live, e. g. Jalacara (aquatic), Sthalacara (terrestrial) and Nabhadaca or Khecara (aerial),²⁹ but same of them are found in only one type of habitat; the members of certain phyle

20. Uttarādhyayana Sūtra, 36.170 ; Bhagavatī Sūtra, 7.5.282; Jivābhigama Sūtra, 1.33 Pāṇṇavāṇī. 1.56, etc.
21. Uttarādhyayana Sūtrā, 36.170. : Bhāgavatī, 7.5.282. ; Pāṇṇavāṇī 1.68 etc.
22. Tattvārthādhigama Sūtra. II. 34 (Potaja); see also Bhagavatī, 7.5.282 for Aṇḍaja and Poṭaja. ; Jivābhigama, 3.1.96.
23. Tattvārthādhigama Sūtrā, II. 34.
24. e. g. Kṛmi has no segmentation, whereas' Pipilikā (ant) upto man ; i. e. some higher Invertebrates and the Vertebrates have segmentation.
25. e. g. the body of Nūpurka (Neura) (earth worm. Annelids has got several segments, each having the same fundamental plan.
26. The segmental character of the body of man is obscured by the covering of the skin.
27. Tattvārthādhigama Sūtra, II. 24. ; Pāṇṇavāṇī, 1.58 (vicchutā).
28. Snāyu (न्हारु), See Kalyānakāraka. 3.2, which mentions 900 nerves in human body (Snāyu) ... nava ... śatāni ”)
29. Bhagavatī Sūtra 7.6.282. ; Jivābhigama Sūtra 1.34. ; Pāṇṇavāṇī Sūtra 1.61, ff.

always live in the sea³⁰, while the members of others are always parasitic³¹ and so on.

Lower Invertebrates

According to the Jaina Āgamas, the movable beings are of three kinds, viz. (1) the fire-lives, (2) the wind-lives and (3) those with an organic body.³² They (the first two) are further sub-divided into subtile and gross animals and developed and undeveloped.³³ Movable beings³⁴ with organic bodies (i. e. animals) are of four classes, viz. (1) those possessing two sense-organs, (2) those with three organs of sense, (3) those with four sense-organ and (4) those with five sense-organs.³⁵ That is to say, they are classified into these groups by counting the senses, actually determining the life-habits. The two-sensed animals upto the four-sensed animals come under the Invertebrate-lower and higher, with problems of terrestrial and aquatic life, while the five-sensed animals including man fall under the category of the Vertebrate of modern Biology.

The Phylum Protozoa

The subtile undeveloped two-sensed animals, e. g. Kṛmin³⁶, etc. of Jaina Biology come under the species of the protozoa of the Lower Invertebrates, i. e. single-celled animals that comprise the first phylum. They are functional complex, even though some appear to be relatively simple structurally. Almost all two-sensed animals like protozoa of modern Biology live in water, from small rain puddles to the ocean.³⁷ Some live in damp soil, in the film of water that surrounds each

30. Paññavānā (Sthānapada) 1.56. ; e. g. Samuddalikkha.

31. Sūtrakṛtāṅga, II, 3.27; SBE XLV, p. 295. ; "Ihegatiyā Sattā . . . paññāvihāṇāṁ tasathāvaraṇāṁ poggalānāṁ sarīresu vā, sacittesu vā, acittesu vā, aṇusūyattā viuṭṭamīti 1", Sūtrakṛtāṅga II, 3.58.

32. Uttarādhyayana Sūtra, 36.107.

33. Ibid. 36.108, 117.

34. Ibid. 36.126.

35. Ibid.

36. Uttarādhyayana Sūtra 36.128.

37. Paññavānā 1.163. Two-sensed animals live in water-places like Agaḍa (a small water-place), Talāya (Tadāga = pond), Nādi (river, Daha (lake), Vāvi (a large oblong pond), Pukkharini (pond), Dihiyā (Dighikā = big tank) (a large water-place), Sāra (lake or water-pools), Sarapāmīti (rows of water pool), Sarasarapāmītiya (many rows of water pools), Bila (hole of pit), Bilapāmītiya (rows of Bilas), Ujjhara (fountain or spring) Nijjhara (waterfall), Cillala (a third of water place), pallala (a kind of Jalāsāya), Vappina, a kind of Jalāsāya), Vappina (a kind of Jalāsāya ?) Diva (Dvīpa = island) and Sumudda (sea).

article of soil³⁸; others live parasitically in the blood and tissue fluids of animals³⁹ or plants, e. g. Kukṣikṛmi⁴⁰ or Kṛmi⁴¹, etc.

Animals with two organs of sense (touch-taste) are of two kinds : subtle and gross. Both are developed or undeveloped.⁴² They are of many kinds, such as, Kṛmis (They arise from putrefying dead bodies) (Śava-Suśruta; of Śarīre Kiyad velāntaram samutpannānāṁ kṛmyādināṁ kathāṁ caitānyām-Guṇaratna, T.R.D. Jainamatam); from decomposing curd or milk (e. g. Varṣāsu ca svedādinā anatidaviyasaiva Kātēna dadhyādyavayavā eva calantah pūtanādi kṛmirūpa, upalabhyante-Jayanta, Nyāyamañjarī, A. 7, Bhūtacaitanyapakṣa), pulakimiyā (a kind of worms born in pāyūpradeśa), Kucchikṛmi⁴³ (Kukṣi intestine or hypoconaria worm in animal blood or tissue fluids of animals), Neura⁴⁴ (Nūpura=earth worm, Annelid), Somaṅgala (a species of two-sensed beings), Alasā (a small poisonous animal),⁴⁵ Māivāhaya (Mātrvāhaka),⁴⁶ Vāsimuhā (Vamśimukhā worms having chisel like mouth curculionidoce), Sūimuhā (Sūcimukhā worms having a needle-like face), Gojaloyā (a two-sensed being), Jaloyā⁴⁶ (Jalaukā, Luches Annelids), Jalauyā (Jalaukā a kind of leech), Sippiyā (shells)⁴⁷, Saṅkhā (Conchifera, Lamelli-branchiata)⁴⁸, Saṅkhanagā (very small, conch - like animals), Ghulla Ghullikā=two-sensed being), Khullā (a kind of two-sensed being), Khullā (a kind of two-sensed beings, lāghavāḥ śankhāḥ small conch-shells, etc.), Varāḍā (Varāṭāḥ Kapardakā, a kind of two-sensed beings, courie), Sottiyā⁵⁰ śuklikā (pearl-mussels,

38. Ibid

29. Pañnavā 1.56.

40. Ibid.

41. Uttarā, 36.128 ; T. S. II. 24.

42. Uttarā, 36.127.

43. Kṛmayāḥ Kosthāpūriṣādivāśpasambhavāḥ-Dalvana ; T. S. II. 24.

44. Nūpuraka (Ring-like), with pendan's, Vermes with unsegmented lateral appendages, Annelids), comes under the category of Annelids, according to modern Biology. It is true that the earthworm (Neura) is a terrestrial animal, but most of the Annelids are marine.

45. Alasā - a small poisonous animal, Petersburg Dictionary, S V. According to the Jīvavicārā Vṛtti V. 16, they are earth snakes (bhūnāga), which originate in the rainy season when the sun is in Aślesha, i. e. about the beginning of July, SBE XLV, p. 219; n. 2.

46. Mātrvāhaka. According to the description of the Avacūri, the larvae of phrygamae seem intended. According to Jīvavicāravṛtti, they are called Kūdeli in Gujarati, SBE., XLV, p. 219, fn. 3.. Jocabi.

47. It comes under the category of Annelids.

48. Some form of Mollusca.

49. Śaṅkha belongs to the group of Mollūscā,

50. It comes under the category of Moliusca.

also thus bādaranigodas also, – paryāptakas and aparyāptas also⁴² should be treated.

Nigodajivas also are thus of seven classes and all are infinite in number from the modal point of view.⁴³

Next the Jivābhigama sutta discusses the comparative numbers (alpatva-bahutva) of all types of Nigodas and Nigodajivas from the substantial and modal points of view.⁴⁴

These ultra microscopic forms of living beings (nigodas) take their name from the very fact that they are tiny enough to exist in infinite number in common Nigodaśarira.⁴⁵ Nigodas do not really reproduce themselves, but they are reproduced in infinite number by the enzymic machinery present in other living cells, as it is suggested by the statement that in the common body when one soul dies, there is death of infinite souls (with it), (while) when one is born, there is the birth of infinite souls there.⁴⁶

Estimates of the size of nigodas have been made in several different ways : The size of the body of a fine-bodied and non-developable nigoda organism in the third instant after it has taken birth in its nucleus (Yoni) is an innumerable part of one (cubic) finger (anguli). This is the minimum (bodily size). The maximum size is found in the fish born in the last and the biggest ocean called Svayambhūramana of the world.⁴⁸

The body of a fine-bodied non-developable Nigoda in a plant body is oblong in the first instant of its birth, square in the second instant, and in the third instant it contracts and becomes circular (or spherical). In the circular state the dimensions of its body are at the minimum, after the third instant it begins to grow,⁴⁹ i. e. it varies widely in size.

42. Niudā ḥum bhamte padesaṭṭhayāe.....aṇamta, evam suhūmaniyāvi pajjattagāvi apajjattagāvi paesaṭṭhayāe savve aṇamta evam, bāyaraniuyāvi pajjattayāvi apajjattayāvi paesaṭṭhayāe savve aṇamta /”, Ibid.

43. “Evam niudajivāva sattavihā paesaṭṭhayāe savve aṇamta /”, Ibid. p. 1000.

44. Ibid., pp. 1000. 1007.

45. Ni = Niyatām, gām = bhūmim, Kṣetram, nivāsamanantānantajivānām dadatiti nigodām /”, Gommaṭasāra, Jivakāṇḍa, v. 191, (comm.), p. 118.

46. “Jatthekka marai jivo tattha du maranām have aṇamtānam / Vakkamai jattha ekko vakkamaṇām tatthaṇamtānam //”, 95.19.

47. “Suhūmanigoda apajjayassa jādassa tadiyasmayamhi / aṅgula asamkhabhāgām jahāṇamukkassayam macche //”, Gommaṭasāra (Jiva) 94.

48. Ibid.

49. Ibid. (Comm.), p. 70

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The Jaina view about the size of Nigoda finds support in modern Biology to some extent in the following manner : "Viruses vary widely in size; one of the largest—the psittacosis virus, the cause of a disease transmitted by parrots and other birds—is about 275 millimicrons in diameter, and one of the smallest, the one causing foot and mouth disease of cattle, is 10 millimicrons in diameter. The electron microscope reveals that some viruses are spherical and others are rod-shaped."⁵⁰

By the operation of the common (Sādhāraṇa) body making karma the bodies of Nigodas become group-souled. They are gross and fine.⁵¹ That is to say, their bodies become group-souled "like huge colonies of viruses" of modern Biology.⁵² "Although individual virus particles cannot be seen, virus-infected cells frequently contain 'inclusion bodies' (i. e. group-souled bodies of Nigodas), which are visible with ordinary microscope. (These are believed to be huge colonies of viruses.)"⁵³

It appears from the study of Jaina Biology that some Nigodas like viruses parasitize bacteria (earth quadrates and bacteria in plant); they are filtrable and will grow only in the presence of living cells—in cultures of bacteria, which they cause to swell and dissolve. These Nigodas are found in nature wherever bacteria occur—"and especially abundant in the intestine of man and other animals (kukşik̄mī?)". They may be compared with Bacteriophages of modern Biology.⁵⁴ "Electron micrographs show that some are about 5 millimicrons in diameter (they vary considerably in size) and that they may be spherical, comma-shaped or they may have a tail and resemble a ping-pong paddle."⁵⁵ Some Nigodas like Rickettsias of modern Biology (resembling viruses) will multiply only within living cells. Their cellular structure is similar in most respects to that of bacteria already defined. Some are spherical, others are rod-shaped, and they vary in length. This Jaina view is supported by Biology in this way that Rickettsias resemble viruses in that with a single exception (a non-pathogenic parasite of the sheep tick), they will multiply only within living cells. Their cellular structure is similar in most respects to that of bacteria. Some

50. Biology, p. 139.

51. "Sāhāraṇodayeṇa nigodasarītā havamītī sāmaṇṇā / Te puṇa duvihā jivā bādara-suhumātī viṇneyā //", Gommaṭasāra, Jivakāṇḍa, v. 191, p. 118.

52. Biology, p. 139; Ni = Niyatām, Gām = Bhūmīm, Kṣetram, nivāsāmaṇītānāntā-Jivānām dadatītī nigodam / That which is always the abode of infinite souls (/) viruses in huge colonies is called Nigoda. qs., p. 118.

53. Biology, p. 139.

54. Ibid., pr. 140-141.

55. Ibid., p. 141.

are spherical, others rod-shaped, and they vary in length from 300 to 2000 millimicrons. They are larger than viruses and hence are non-filtrable and just barely visible under the microscope.”⁵⁶

ALGAE (Sevāla)

According to the Jaina Āgamas, the more primitive plants, which neither form embryos during development nor have vascular tissues, e. g. Sevāla⁵⁷ (algae) and Panaga⁵⁸ (fungus) may be identical with Thallophytes of modern Biology.⁵⁹ The Thallophytes are classified into two kinds, viz. Algae (Sevāla) (those that have [chlorophyll and can live independently) and Fungi (pañaga)⁶⁰ (those that lack chlorophyll and must live as saprophytes or parasites) (aṇusūyattāe).

Algae are primarily inhabitants of water (Jalaruha),⁶¹ –fresh or salt water, but according to Biology, “a few of them live on rock surfaces and on the bark of tree. The ones living in such comparatively dry places usually remain dormant when water is absent.”⁶²

Algae are important food producers by virtue of their tremendous numbers, as all of the photosynthesis in fresh water or in the sea is carried on by algae. According to Biology, there are many kinds of algae, such as, blue-green algae, green algae, brown algae, red algae etc.⁶³

Fungi (Pañaga) :

The simple plants that lack chlorophyll are called fungi (pañaga). The true fungi include rust, smuts, mushrooms, toad-stool, etc. They are of five colours—red, yellow, grey (or cloudy), black and white.⁶⁴

In a fungus, such as, the mushroom (Kuhana), the mycelium is below ground; the mushroom cap that is eaten is a fruiting body that grows out from the mycelium. According to modern biology, “Fungi are either saprophytic or parasitic and are found universally wherever organic material is available; they grow best in dark, moist habitats.”⁶⁵

56. Ibid., p. 142.

57. “Pañagattāe Sevalattāe”, etc.; Sūtrakṛtāṅga II. 3.5; Pañnavanā, I. 51, p. 21; “Pañaga sevāla-bhūm-iphoḍa ya /”, Jivavicāra 8.

58. Uttarādhyayana Sūtra, 36.103-104; Pañnavanā I.51, p. 21; “Pañagā sevāla - bhūmiphoḍa ya /”, Jivavicāra, v. 8.

59. Biology, p. 145.

60. Ibid.; Sūtrakṛtāṅga, II. 3.55.

61. Pañnavanā, I. 5; Panaga also is jālaruha.

62. Biology, p. 145.

63. Ibid., pp. 147-152.

64. Jivavicāra, p. 133.

65. Biology, p. 155.

(Fifth Section)

Evolution of Plant Reproduction

It appears from the study of the Jaina Āgamas that in plants, much more clearly than in animals, an evolutionary sequence is evident ranging from forms, such as, the blue greens (algae)¹ and bacteria² which reproduce by asexual means, to ones with complicated life-cycles and highly evolved adaptations until it is capable of leading an independent life. Some of the lower forms, such as, fungi (Pañaga)³ which has no reproductive specializations, produce billions of spores so that by chance a few will fall in an environment favourable for germination and survival. The higher plant may produce no more than a few score seeds⁴ per plant but each seed has a fairly good chance of growing into a mature plant.

Asexual Reproduction

According to Jaina Biology, asexual reproduction⁵ takes place in plant life. Asexual reproduction is characterized by the presence of a single parent, one that splits, buds, fragments or produces many spores⁶ so as to give rise to two or more offsprings. It is stated in the Sūtrakṛtāṅga that there are, all in all, in the world four kinds of seeds (for reproduction), viz. seeds generated at the top (of the plant), (2) at its root, (3) at its knots and (4) at its stem.⁷ According to the seed and place (of growth) of these plants, some beings-born in earth,

1. Sevāla, Sūtrakṛtāṅga II. 3.55; Pañnavanā 1.51, p. 2; Jīvavicāra 8.
2. For plant bacteria see Bhagavati Sūtra, 7.3. 276; 8. 3. 324; Uttarādhyayana Sūtra, 36. 96; Pañnavanā Sūtra, I. 40 ff; Gommaṭasāra (Jīvākāṇḍa), V. 189, p. 117; For Earth quadrates see Sūtrakṛtāṅga, Book I, Bhagavati, 33. 1. 884; Uttarādhyayana Sūtra 36.70, 84, 92, 108, 117; Pañnavanā; Gommaṭasāra (Jīvākāṇḍa) 89, p. 68; Lokaprakāśa, 4th Sarga; v. 25; 5th Sarga, v. I ff.
3. Sūtrakṛtāṅga II. 3.55 (Pañaga); Pañnavanā I. 51, p. 21; Jīvavicāra 8 "Pañaga Sevāla bhūmiphodaya /"
4. Sūtrakṛtāṅga II. 3.43. (aggabija)
5. Sūtrakṛtāṅga II. 3. 43, "Logaṇīśi cattāi biyakāyā evamhijjamīti, tamjahā-aggabiyā mūlabiyā porabiyā khamdhabiyā." The commentators give the reading of the Nāgārjuniyas. "Nāgārjuniyāstu pañhanti. "Vaṇassaikāṇa pāñcavihā bijāvakkamīti evamāhijjai-tamjahā aggamūlaporukkhaṁ-dhabiyaruhā, chaṭṭhāvi egeṇdiyā sam-mucchimā biyā jayamīte." Sūtrakṛtāṅga (comm.), II. 3-43, p. 94. "Mūlaggaporebiyā kāṇḍā taha khamdhabijabijaruhā Sammucchima ya bhaṇiyā patteyāṇāmītakāyā ya /", Gommaṭasāra (Jīva), 196.
6. Sūtrakṛtāṅga II. 3.43.
7. Ibid., II. 3 43.

originated in earth, and grown in earth, having it in their birth, origin, and growth, being impelled by their Karman, and coming forth in it on account of their Karman, growing there in particles of earth, the origin of various things—come forth as trees.⁸

For most blue-greens-algae⁹ and plant bacteria¹⁰ asexual reproduction is the only means by which new individuals are produced. Even in the higher plants reproduction may take place asexually in a variety of ways, as pointed out, e. g. plants from seeds generated at the top (of the plant), at its root, at its knots, at its stem.¹¹ Rice plants grow from seeds, gingers from roots, sugarcane from knots and plantains from stem,¹² rose plant from shoot, onion from bulb (kanda), and grasses have spontaneous reproduction (Saṁmūrechim).¹³

Most of the cultivated trees and shrubs are reproduced from the cutting of stems, which sprout roots at their tips when placed in moist ground, e. g. sugarcane.¹⁴ A number of commercial plants-bananas (Kadali),¹⁵ etc. have lost their ability to produce functional seeds and must be propagated entirely by asexual means from the stem.¹⁶

Many plants, such as ground,¹⁷ etc. develop long, horizontal stems called runners (Valli).¹⁸ They grow several feet along the ground in a single season and may develop new erect plants at every other mode. Other plants spread by means of similar stems, called rhizomes, which grow underground, e.g. Bhadramutthā,¹⁹ Seṇiya (a kind of grass), Bhattiya, Dabbha²⁰ (a kind of grass), etc. are particularly difficult to control because they spread by means of runners or rhizome. Swollen underground stems or tubers, such as, white patato, suraṇakanda²¹ (Amor-

8. Ibid., II 3.43.

9. Ibid., II. 3.4 "Ihegāliā Sattā udagajoniyā udagasaṁbhavā.....Sevālattā.....Viuṭṭamū"

10. Bhagavatī, 7.3.276; 8.3.324; Uttarādhyayana Sūtra, 36.96; Paññavānā Sutta I, 40 ff.; Gommaṭasāra (Jiva), V. 189, p. 117.

11. Sūtrakṛtāṅga II, 3.43.

12. Sālyādayo vā... .te agrabijāḥ, tathāmūlabijā ādrankādayāḥ, parvabijatvikṣvādayāḥ, skandhabijāḥ sallakyādayāḥ /", Ibid. (Comm.), p. 94.

13. Gommaṭasāra (Jivakāṇḍa), V. 186. (Comm.), p. 116.

14. Sūtrakṛtāṅga II. 3.43. (Comm.); "Parvabijātvikṣvādayā.", p. 94.

15. "Skandhabijāḥ Sallakyādayāḥ" Ibid. II. 3.43 (Comm.), p. 94.

16. Ibid.

17. "Tumbī", Paññavānā, I, 1.45, p. 19.

18. Paññavānā, I. 1.45, p. 19.

19. Bhaddamuttha (a species of cyperus), Bhagavatī Sūtra, 7.3.277; 8.3.324.

20. Paññavānā I. 47, p. 20; Bhagavatī Sūtra, 21.2.91.

21. Gommaṭasāra (Jiva), V. 186. (Comm.), Bhagavatī 7.3.277; 8.3.324; Paññavānā, 1.54. 53, p. 22; Uttarā 36.98; Biology, p. 174, C. P. Villee

phophallus, Campanulatus), etc. also serve as a means of reproduction; "in fact, some of the cultivated varieties of patato rarely, if even, produce seed and must be propagated by planting a piece of a tuber containing bud or 'eye'."

Some beings born in trees...originated by trees, sprung from trees, etc., springing from tree that originated in earth, come forth as trees originated by trees.²²

"Some beings born in trees, growing in trees, that are originated by trees, come forth as their roots, bulb, stem, branches, twigs, leaves, flowers, fruits, and seeds."²³

In the same way creepers,²⁴ grasses,²⁵ herbs,²⁶ and small plants²⁷ are to be known in regard to their reproduction.

"Some beings born in earth; growing there in particles of earth that are the origin of various things, come forth as Āya, Vāya, Kāya, Kuhana (mushroom), Kanduka, Uvvehaliya (or Uvvehaṇiya), Nivvehaliya (or Nivvehaṇiya), Esava, Sacha, Chattaga, Vāsāṇiya²⁸ and Kūra."²⁹

"Some beings born in water, originated in water, grown in water, etc. come forth as trees, creepers, grass, herbs and plants."³⁰

"Some beings born in water, growing in particles of water that are the origin of various things, come forth as Udaga, Avaga,³¹ Paṇaga (fungus), Sevāla³² (algae), Kalaṁbuga,³³ Hada, Kaśeruya, Kacchabhāṇiya,

22. Apparently trees sprung from shoots, sprouts, aerial-roots, etc. are meant. They are considered as a class different from those whose offshoots they are. S.B.E., XLV, p. 380.
23. One soul (jīva) pervades the whole tree; it is the soul of the tree. Separate jīvās (beings), however, reside in the roots, etc., S.B.E., XLV, p. 390; Sūtrakṛtāṅga II. 3.50.
24. Ajjhāruha = adhyāroha, explained in the Dipikā: Vallivṛksa; Ibid. (Sūtrakṛtāṅga), II. 3.50.
25. Tṛṇa, Ibid.
26. Osahi = Oshadhi, Ibid., p. 391; Sūtrakṛtāṅga II. 3.50.
27. Hariya = harita, Ibid.; Sūtrakṛtāṅga II. 3.50.
28. "All the commentators say about the words; Āya, etc. (which offer some various readings in the MSS) that they denote particular plants (Vanaspativīśeṣa) which must be learned from people (who know them)." Jacobi gives the words in their Prākrit form, and does not attempt to transpose them into Sanskrit.
29. Sūtrakṛtāṅga, II. 3.54; S.B.E. XLV, p. 391
30. Ibid.
31. Avaka, a grassy plant growing in marshy land (Blyxa octandra), Ibid.
32. Śaivāla, the aquatic plant Vallisneria (alge) Ibid.; Sūtrakṛtāṅga II. 354.
33. Kadamba, Nauclea Kadamba; S.B.E., XLV, p. 391.
34. Kaseru, Scirpus Kysoor, Ibid.

Uppala (Utpala), Pauma (Padma), Kumuya (Kumuda), Nalina,³⁵ Subhaga, Sogamdhya, Poṇḍariya (Puṇḍarīka), Mahāpoṇḍariya (Mahā-puṇḍarīka), Sayavatta (Śatapatra), Sahassavatta (Sahasrapatra), Kalhāra, Kakanada, Aravinda and Tāmarasa,³⁶ as stalks and fibres of lotus, as Pukkhala,³⁷ and Pukkhalaṭṭhibhaga.³⁸

This brief account of plant reproduction as given in the Jaina texts shows that there takes place only asexual reproduction in all types of plants according to Jaina Biology. One soul pervades the whole tree, it is the soul of the tree. Separate jīvas (beings or bacteria), however, reside in its roots, bulbs, stem, bark, branches, twigs, leaves, flowers, fruits and seeds.³⁹

The Bhagavatī Sūtra⁴⁰ refers to ten instincts including maithuna (sexual union) of all beings—one-sensed to five-sensed beings. It is stated that Kuravaka trees bear fruits after embracing a female part of it. This may be interpreted as the sexual union of this tree.⁴¹ It is suggestive from this evidence that sexual reproduction also may take place in plant life. But according to Jaina Biology, there is no clear reference to sexual reproduction in plants, which involves the co-operation of two parents, each of which supplies one gamete and two gametes unite to form zygote. Very vague ideas are contained in other Indian works⁴² as to the sexual reproduction of plants.

35. The last four are well-known varieties of lotus, called in Sanskrit : Utpala, Padma, Kumuda, Nalina, *Ibid.*, p. 392.

36. The Sanskrit of the last seven items is : Puṇḍarīka, Mahāpuṇḍarīka, śatapatra, Sahasrapatra, Kahlāra, Kokanada and Tāmarasa; they are all Varieties of lotus. *Ibid.*, p. 392.

37. Puṣkara, *Ibid.*

38. Sūtrakṛtāṅga II, 3.5ⁱ, p. 93.

39. “ Yo hi ekaḥ vanaspati jīvali sarvavṛkṣāvayavavyārī bhavati, tasya cāpare tadavayaveṣu mūlakandaskandhatvakaṣākhāpravālapatrapusphalabijabhūteṣu daśaśūstheṣu jīvāḥ samutpadyante / ” Sūtrakṛtāṅga II, 3.55 (Comm.), p. 96.

40. “ Āhārabhaya pārigahamehuṇa taha koha māṇa māyā ca / Lobho logo oho sannā dasa savvajivāṇām ”, Lokaprakāśa 3.447; “ āhārasannā to ohasannā ”, Bhagavatī Sūtra, 7.8.29.

41. “ Itthiparirāmbhaṇeṇa Kurubagatruṇo phalamti, mehūṇai ”, Lokaprakāśa, 3.449. There takes place sexual union in Aśoka tree also.

42. “ Sīrīnām sumanasām puṣpām prasūnām samam ”, Amāra, Vanauṣadhibhārga, Bṛhatphalāśvetapuṣpāiḥ /, (pumān, Holarrhena antidysenterica), Caraka (Dr̥dhvala), V. Syāvārunānupuṣpī stri – sitakūṭaja, Wrightia tinctoria, *Ibid.* V, “ Anūpādi prathamo vargah stripuṣṇapīḥ katvena traividhyām sthāvareṣvapi ”, Rājñanighaṇṭu, vide Positive Sciences of the Ancient Hindus, p. 175.

The Life Cycle of Plant

The-life cycle of any species—plants or animals is the biologic processes of development which take place between any given point in any organism's life-span and the same point in the life-span of its offspring. For bacteria (earth quadrates)⁴³ and plant bacteria,⁴⁴ blue-greens (algae = Śaivāla)⁴⁵ which reproduce by splitting (a kind of asexual reproduction), the life cycle is extremely simple. According to modern Biology, “The filamentous green algae, such as Ulothrix, have a cycle during most of which, the colony consists of haploid cells which multiply asexually by mitosis.”⁴⁶

In the higher plants there are clearly found their life-cycle stages of infancy, youth and age⁴⁷ like those of human body, etc. Parasitic plants⁴⁸ have complex life cycles involving host organisms.⁴⁹

According to Jaina Biology, the plants show an act of generation—generation which reproduces asexually by spores.⁵⁰ It is known as the sporophyte. Besides, they are reproduced from the root, the knot and stem.⁵¹ The life-cycle of such plants consists of the production of haploid spores by the sporophyte. The relative size and duration of the different sporophyte generations vary considerably. The sporophyte is the familiar, visible tree, shrub or herb.

Germination of the Seed and Embryonic Development

Jaina biology throws some welcome light upon the germination of the seed and embryonic development. When the seeds are ripe, they are shed from the parent plant, but a few of them do germinate shortly after being shed; most of them remain dormant during the cold

43. Sūtrakṛtāṅga, Book I, Lecture 7, V. I; Puḍhavī ya āu aganīya vāū; Gommaṭasāra 73 (Jivakāṇḍa).

44. Bhāgavatī, 7.3.275-7; Gommaṭasāra, V. 189. (Jivakāṇḍa); Pañṇavāṇā I.54 (Sādharaṇaśāśvīravāṇaspati kayikas).

45. Sūtrakṛtāṅga II. 3.54. (Sevālattāe); Pañṇavāṇā I. 54. (Jalaruhā-sevāla).

46. Biology, p. 178.

47. “Yathā puruṣaśāśvīrām bālakumārayuvavṛddhatāparināmaviśeṣavat.”....tathedam vanaspatiśāśvīrām /”, Śaddarśanasamuccaya, V. 49, Tarkarahasyadīpikā, Guṇaratna, p. 157.

48. “Ihegatiyā sattā rukkhajoniyā rukkhasaṁbhavā rukkhavukkamā . . . rukkha-joniesu rukkhattāe viuṭṭāmī, te jivā tesinā rukkhajoniyām rukkhānām siñehā-māhāreṇī /” Sūtrakṛtāṅga, II. 3.45; “Nāñāvihāṇām tasathāvāraṇām poggalāṇām sariresu vā, sacitesu vā, acitesu vā, aṇusūyattāe viuṭṭāmī”, Ibid., II. 3.58.

49. Ibid.

50. Sūtrakṛtāṅga II. 3.43.

51. “Aggabīyā mūlabīyā porabīyā khaṇḍhabīyā”, Ibid., II. 3.43.

or dry season and germinate only with the advent of the next favourable growing season.⁵² A prolonged period of dormancy usually occurs only in seeds with thick or waxy seed-coats which render them impenetrable to water and oxygen.

The life of some higher plants exists within the cover of seeds in state of dormancy to be awakened at a proper time and season under the favourable conditions. The life persists within the protective seed-coat for certain period, resisting against all the forces of the natural phenomena. In due time and season this dormant life springs up, bursting asunder the seed-coat and begins to grow gradually into a full plant like all beings, though in its immobile state, due to the transformation within itself.⁵³

The length of time that a seed will remain viable and capable of germination varies greatly. The viability of the cereals, such as, Śāli, Brihi, Godhūma (Wheat), etc., if preserved in a well-protected granary, lasts in the minimum for an antarmuhūrta and in the maximum upto three years, that of pulses, such as, Kalāya (a kind of pulse), Masura (lentil), Mung (Phaseolus Mungi), etc., for an antarmuhūrta in the minimum and five years in the maximum and that of Alasi (linseed), Kusumbhaka (Carthamus tinctorious), Kodrava (Paspalum scrobiculatum), Kangri (millet or a kind of parric seed), Śana (flax), Sarṣapa (mustard seed). Mūlaga (radish seed), etc., for an antarmuhūrta in the minimum and seven years in the maximum, provided they are stored up scientifically. After the specified periods their respective viability withers away and the seeds become unseeds without having germinating capacity.⁵⁴

This evidence of Jaina Biology regarding viability of seeds finds support in modern Biology in this way. "Willow and poplar seeds must germinate within a few days of being shed or they will not germinate at all; ⁵⁵ seeds of the evening primrose and of yellow dock were able to germinate after seventy years".⁵⁶ There are authentic

52. Bhagavati, 15.1.544. It throws light upon the germination of sesamum seeds with the advent of favourable growing season after the uprooting of the Sesamum-plant by Gośala Mañkhaliśutta.

53. Bhagavati Sūtra, 15.1.544; See Plant Autographs and their Revelations, Sir J. C. Bose, 1927.

54. Bhagavati Sūtra 6.7.246.

55. Biology, p. 186.

56. Ibid.

records of lotus seeds germinating 200 years after being shed.⁵⁷ The ability of a seed to retain its germinating power depends on the thickness of the seed-coat, on a low water content, and on the presence of starch rather than fats as stored food material. Dormant seeds are alive and do metabolize, though at a very low rate.⁵⁸

The reference to *Joṇibbhūe bie* (embryonic seed), hypocotyle (first radicle=mūla), cotyledons (prathamapatras), epicotyle (prathama Kiśalaya) and its development of growth (vivadḍhamita), their simultaneous birth, formation of plant body (samayaṁ vakkamītaṇam samayaṁ tesīm sariranivvatti), receiving of matter (warmth and moisture, etc.) and respiration (samayaṁ āṇugghaṇam samayaṁ ūsāsa-nisāse)⁵⁹ suggests that germination is initiated by warmth and moisture and requires oxygen. The embryo and endosperm absorb water, swell and rupture the seed-coats (Uggamamāṇa).⁶⁰ This frees the embryo and enables it to resume development (Vivadḍhamta).

After germination the hypocotyle (mūla) elongates and emerges from the seed-coat (vakkamai). "The primitive root or radicle grows out of the hypocotyle⁶¹ and since it is strongly and positively geotropic, it grows directly downward into the soil."⁶² "The arching of the hypocotyle in a seed such as the bean pulls the cotyledons (i.e. prathamapatras) and epicotyle (kiśalaya or amkura) out of the seed-coat and the epicotyle, responding negatively, to the pull of gravity grows upward.⁶³ The cotyledons (prathamapatras) digest, absorb and store food from the endosperm, while within the seed. The Cotyledons of some plants shrivel and drop off after germination; those of other plants become flat foliage leave. The cotyledons contain reserves of food that supply the growing seedling (kisalaya) until it develops enough chlorophyll to become independent. The stem (skandha) and leaves (patras) develop from the epicotyle (first Kiśalaya).⁶⁴

57. Ibid.

58. Ibid.

59. "Joṇibbhūe bie jivo vakkamai so vā āṇo vā / Jo vi mūle jivo so vi ya patta paḍhamatāe" //97// "śavvo vi kisalayo khalo uggamamāṇo aṇamītayō bhaui / so ceva vivadḍhamta hoi paritto aṇamīto vā // 98 //" "Samayaṁ vakkamītaṇam samayaṁ tesīm sariranivvatti / Samayaṁ āṇugghaṇam samayaṁ ūsāsa-nisāse //99// Pannavāṇā 1.54, 9-10, 97-9

60. Ibid.

61. Biology. p. 187.

62. Ibid.

63. Biology, p. 187.

64. See above the embryonic development of plant.

Evolutionary Trends in the plant kingdom.

As we glance back over the many types of plant life cycles that are found from algae to angio-sperms, a number of evolutionary trends appear to be evident. One of these is a change from a population that is mostly haploid individuals to one that is a most entirely diploid—an evolutionary trend toward a greater size and importance of the sporophyte⁶⁵ and a reduction in the size of the gametophyle generation.

65. Sūtrākṛtaṅga II. 3.43

THIRD CHAPTER
ANIMALS AND THEIR CLASSIFICATION
(First Section)

Classification of Animals : Lower Invertebrates

INTRODUCTION

To catalogue the vast array of animals the Jainācāryas have used a classification system of animals based upon observation of similarities of structure¹, sense-organs², mode of origin³ and development.⁴ In the study of taxonomy they have differentiated superficial and accidental similarities from the significant fundamental ones. Homologous structures⁵ of various animals (which arise from common rudiments and are similar in basic plan and development) have been distinguished from analogous structures⁶ (which are similar in function). Accordingly the arm of a man, the wing of a bird, the fin of a fish are homologous⁷, with basically similar structural plan and similar

1. E. G. Catuśpadas (quadrupeds) Egakhurā (Solidungular), Dukhurā (Biungular), Gamḍipayā (Multiungular), and Saṇapapphayā (animals having toes with nails); Parisarpas (reptiles) - Bhujaparisarpas (those which move on arms) and Uraḥparisarpas (those which move on breast); Uttarādhyayana Sūtra 36; 179-181; Paṇṇavaṇā I. 69, 70; 1-76.; Tattvārthādhigama Sūtra II. 24
2. Bhagavatī, 1.5. 48-49; 2.1. 83-84; 9. 32. 37; 20. 1. 663; 24. 17. 708-712.
Uttarādhyayana Sūtra, 36. 177; 136, 150-155, Paṇṇavaṇā Sutta, 1. 56, 57, 58, 61-91, 92-138. "Kṛmyādinām pipilikādinām bhramarādinām manusyādinām ca / yathāsaṅkhyām kaikavṛddhāni indriyāni bhavanti yathākramam / Tad yathā kṛmyādinām apādikanūpurakagaṇḍupada - śaṅkha - śuktika - śambuka - jalukā - prabhṛtiṇām sparsanaranasanendriye bhavataḥ I sesānām ca Tiryag-yonijānām matsyoragabhujaṅga - pakṣicatuśpadānām sarveśām ca nārakamanuṣyadevānām pāncendriyāni /" Tattvārthādhigama Sūtra, II. 24.
3. Bhagavatī 7.5.282; 9.32.375; Uttarādhyayana Sūtra 36.170;
Jīvābhigama Sūtra 1.33.
; Paṇṇavaṇā Sūtra, 1.56 (Saṁmūcchimā).
" , " 1.57 (Saṁmūcchimā).
" , " 1.58 (Saṁmūcchimā).
" , " 1.68 (Saṁmūchhimā and
" , " 1.75 Gabbhavukkāṁtiya).
" , " 1.84 " ; Tattvārthādhigama 1.85 " ;
Sūtra II. 34
4. Ibid.
5. Arms of man, wings of birds, fin of fish are homologous ; Tattvārtha Sūtra II. 34.
6. Wings of bat and bird are analogous structures.
7. Paṇṇavaṇā I. 92,138 (Manussa) : 1.86 (Khchacara); 1.62-63.

embryonic origins⁸. Structure of animals may be both homologous and analogous, e. g. the wings of birds and bats⁹ have a similar structural plan and development, as well as the same function.¹⁰

Because all animals have essentially the same problems to solve in order to survive, there is basic unity of life among them.

The Basis For Animal Classification According to Jaina Biology.

According to Jaina Biology, the main divisions of the animal kingdom, the phyla, are differentiated by basic characteristics which usually are not unique for a single phylum, but occur in unique combinations in various ones. Some factors basic to the determination of an animal classification are as follows :

(a) The presence or absence of cellular differentiation¹¹ and the presence of sense-organs—two to five-sense-organs.¹² Animals may be either single-celled, e. g. kṛmi¹³ (the protozoa), or composed of many kinds of cells, specialized to perform particular tasks in the body's economy, e. g. higher animals and man having five sense-organs.¹⁴ In all the higher animals, cells are differentiated and specialized. Besides, animals may be either two-sensed¹⁵ or three to five-sensed.¹⁶

(b) The type of body-symmetry, whether spherical¹⁷, radial¹⁸ or bilateral.¹⁹ Animal bodies may be organized to one of the three types of symmetry.

8. Paññavānā 1.68, 75, 84, 85, 91, 92 ; Tattvārthādhigama Sūtra II. 34
9. Wings of Cammapakkhi and Lomapākkhi ; Paññavānā 1.86.
10. Ibid., (Wings of bats and birds have the same function).
11. Most of the two-sensed animals have one-celled body, e.g. kṛmi (worm), while five-sensed animals have cellular differentiation;
12. Bhagavatī Sūtra, 1.5. 49; 2.1. 8½-84; 9. 32-375; 20 1.663; 24.17.108-12. Uttarādhyayana Sūtra 36.127; 136: 150-155 Paññavānā Sūtra, 1.56, 57, 58, 61-91, 92-138. ; Tattvārthādhigama Sūtra II. 24.
13. Uttarādhyayana Sūtra 36.128 ; Paññavānā 1.56 ; Tattvārthādhigama Sūtra II. 24. (Kṛmyādināin, etc.)
14. Pancendriyas ... , Uttarādhyayana Sūtra 36.155; 170, etc. ; Tattvārthādhigama Sūtra II. 24.
15. Uttarādhyigama Sūtra 36.128 ; Paññavānā Sūtra 1.56 ; Tattvārthādhigama Sūtra II. 24.
16. Uttarādhyayana Sūtra 36.155 ; Paññavānā Sūtra, 1.61-91; 1.62.
17. A few of the lowest animals have this type of spherical symmetry.
18. In radial symmetry two sides are distinguishable, a top and a bottom, as in a starfish.
19. Human beings and all higher animals have bilateral symmetry, in which only one special cut will divide the body into two equal halves, e.g. the body of a man has bilateral symmetry anterior and posterior, dorsal and ventral sides.

(c) The number of modes of origin, generation, e. g. Sammūrcchima²⁰ (generatio aequivoca or asexual reproduction) and Garbhavyutkrāntika²¹ (generation from the womb, sexual reproduction)-āñdaja (Oviparous generation), Jarāyuja (Viviparous) and potaja (viviparous generation without the placenta).²² {Some of the metazoa (higher animals) have only two embryonic cell layers or germ layers-an outer ectoderm and an entoderm, e. g. jarāujas and potajas.²³

(d) The presence or absence of segmentation.²⁴ The members of several phyla are characterized by the fact that their bodies consist of a row of segments,²⁵ each of which has the same fundamental plan, with or without variation, as the segments in front and behind. In some segmental animals, such as, man and most vertebrates the segmental character of the body is obscured.²⁶ In man the bones of the spinal column - the Vertebrae - are among the few parts of the body till clearly segmented.

(e) Unique features : There are only a few structures that belong exclusively to one phylum of the animal world, e. g. vṛscikas (scorpions)²⁷ alone have sting cells (nematocysts); although many kinds of animals have a nervous system, only the chordates to which man belongs, have a dorsally located, hollow nerve cord.²⁸

In Jaina Biology, animals are also classified according to the environment in which they live, e. g. Jalacara (aquatic), Sthalacara (terrestrial) and Nabhadaca or Khecara (aerial),²⁹ but same of them are found in only one type of habitat; the members of certain phyle

20. Uttarādhyayana Sūtra, 36.170 ; Bhagavatī Sūtra, 7.5.282; Jivābhigama Sūtra, 1.33 Pañnavanā. 1.56, etc.
21. Uttarādhyayana Sūtrā, 36.170. : Bhāgavatī, 7.5.282. ; Pañnavanā 1.68 etc.
22. Tattvārthādhigama Sūtra. II. 34 (Potaja) ; see also Bhagavatī, 7.5.282 for Āñdaja and Poṭaja. ; Jivābhigama, 3.1.96.
23. Tattvārthādhigama Sūtra, II. 34.
24. e. g. Kṛmi has no segmentation, whereas! Pipilikā (ant) upto man ; i. e. some higher Invertebrates and the Vertebrates have segmentation.
25. e. g. the body of Nūpurka (Neura) (earth worm. Annelids has got several segments, each having the same fundamental plan.
26. The segmental character of the body of man is obscured by the covering of the skin.
27. Tattvārthādhigama Sūtra, II. 24. ; Pañnavanā, 1.58 (vicchutā).
28. Snāyu (न्हारु), See Kalyānakāraka. 3.2, which mentions 900 nerves in human body (Snāyu) ... nava ... śatāni ”)
29. Bhagavatī Sūtra 7.6.282. ; Jivābhigama Sūtra 1.34. ; Pañnavanā Sūtra 1.61. ff.

always live in the sea³⁰, while the members of others are always parasitic³¹ and so on.

Lower Invertebrates

According to the Jaina Āgamas, the movable beings are of three kinds, viz. (1) the fire-lives, (2) the wind-lives and (3) those with an organic body.³² They (the first two) are further sub-divided into subtle and gross animals and developed and undeveloped.³³ Movable beings³⁴ with organic bodies (i. e. animals) are of four classes, viz. (1) those possessing two sense-organs, (2) those with three organs of sense, (3) those with four sense-organ and (4) those with five sense-organs.³⁵ That is to say, they are classified into these groups by counting the senses, actually determining the life-habits. The two-sensed animals upto the four-sensed animals come under the Invertebrate-lower and higher, with problems of terrestrial and aquatic life, while the five-sensed animals including man fall under the category of the Vertebrate of modern Biology.

The Phylum Protozoa

The subtile undeveloped two-sensed animals, e. g. Kṛmin³⁶, etc. of Jaina Biology come under the species of the protozoa of the Lower Invertebrates, i. e. single-celled animals that comprise the first phylum. They are functional complex, even though some appear to be relatively simple structurally. Almost all two-sensed animals like protozoa of modern Biology live in water, from small rain puddles to the ocean.³⁷ Some live in damp soil, in the film of water that surrounds each

30. Paññavanā (Sthānapada) 1.56. ; e. g. Samuddalikkha.

31. Sūtrakṛtāṅga, 11, 3.27; SBE XLV, p. 295. ; "Ihegatiyā Sattā . . . paññāvihāṇām tasathāvarāṇām poggālāṇām sariresu vā, sacittesu vā, acittesu vā, aṇusūyattām viuṭṭamti 1", Sūtrakṛtāṅga 11. 3.58.

32. Uttarādhyayana Sūtra, 36.107.

33. Ibid. 36.108, 117.

34. Ibid. 36.126.

35. Ibid.

36. Uttarādhyayana Sūtra 36.128.

37. Paññavanā 1.163. Two-sensed animals live in water-places like Agaṇa (a small water-place), Talāya (Tadāga = pond), Nadi (river, Daha (lake), Vāvi (a large oblong pond), Pukkharini (pond), Dihiyā (Dighikā = big tank) (a large water-place), Sāra (lake or water-pools), Sarapāṇti (rows Gunjaliyā (a large water pool), Sarasarapāṇtiya (many rows of water pools), Bila (hole of pit), of water pool), Bīlapāṇtiyā (rows of Bīlas), Ujjhara (fountain or spring) Nijjhara (waterfall), Bīlapāṇtiyā (rows of Bīlas), Cillala (a third of water place), pallala (a kind of Jalāsāya), Vappina, a kind Cillala (a third of water place), Vappina (a kind of Jalāsāya ?) Diva (Dvīpa = island) and Sumudda (sea).

article of soil³⁸; others live parasitically in the blood and tissue fluids of animals³⁹ or plants, e. g. Kukṣikṛmi⁴⁰ or Kṛmi⁴¹, etc.

Animals with two organs of sense (touch-taste) are of two kinds : subtile and gross. Both are developed or undeveloped.⁴² They are of many kinds, such as, Kṛmis (They arise from putrefying dead bodies) (Śava-Suśruta; of Śarire Kiyad velāntaram samutpannānāṁ kṛmyādināṁ katham caitānyam-Guṇaratna, T.R.D. Jainamataṁ); from decomposing curd or milk (e. g. Varṣāsu ca svedādinā anatidaviyasaiva Kātēna dadhyādyavayavā eva calantah pūtanādi kṛmirūpa, upalabhyante-Jayanta, Nyāyamañjari, A. 7, Bhūtacaitanyapakṣa), pulakimiya (a kind of worms born in pāyūpradeśa), Kucchikimi⁴³ (Kukṣikṛmi born in Kukṣi intestine or hypoconaria worm in animal blood or tissue fluids of animals), Neura⁴⁴ (Nūpura = earth worm, Annelid), Somaṅgala (a species of two-sensed beings), Alasā (a small poisonous animal),⁴⁵ Māivāhaya (Mātrivāhaka),⁴⁶ Vāsimuhā (Vamśimukhā worms having chisel like mouth curculionidoce), Sūimuhā (Sūcimukhā worms having a needle-like face), Gojalyā (a two-sensed being), Jaloyā⁴⁶ (Jalaukā, Luches Annelids), Jalauyā (Jalaukā a kind of leech), Sippiyā (shells)⁴⁷, Saṅkhā (Conchifera, Lamelli-branchiata)⁴⁸, Saṅkhanagā (very small, conch - like animals), Ghulla Ghullikā = two-sensed being), Khullā (a kind of two-sensed being), Khullā (a kind of two-sensed beings, lāghavāḥ śankhāḥ small conch-shells, etc.), Varāḍā (Varāṭāḥ Kapardakā, a kind of two-sensed beings, courie), Sottiyā⁵⁰ śuklikā (pearl-mussels,

38. Ibid

29. Paṇṇavā 1.56.

40. Ibid.

41. Uttarā, 36.128 ; T. S. II. 24.

42. Uttarā, 36.127.

43. Kṛmayāḥ Kosthāpūriśādivāśpasambhavāḥ-Dalvana ; T. S. II. 24.

44. Nūpuraka (Ring-like), with pendants, Vermes with unsegmented lateral appendages, Annelids), comes under the category of Annelids, according to modern Biology. It is true that the earthworm (Neura) is a terrestrial animal, but most of the Annelids are marine.

45. Alasā - a small poisonous animal, Petersburg Dictionary, S. V. According to the Jivavicārā Vṛtti V. 16, they are earth snakes (bhūnāga), which originate in the rainy season when the sun is in Aślesha, i. e. about the beginning of July, SBE XLV, p. 219; n. 2.

46. Mātrivāhaka. According to the description of the Avacūri, the larvae of phrygamae seem intended. According to Jivavicāravṛtti, they are called Kūdeli in Gujarati, SBE., XLV. p. 219, fn. 3., Jocabi.

47. It comes under the category of Annelids.

48. Some form of Mollusca.

49. Saṅkha belongs to the group of Mollūscā,

50. It comes under the category of Moliusca.

Lamelli-branchiata), Mottiyā (Mauktikā – a kind of pearls), Kaluyā (a kind of two-sensed being), Vāsā (a kind of two-sensed beings), Egaovattā (a kind of two-sensed beings), Duhaovattā (a kind of two-sensed being), Nāmdiyā vattā (a kind of two-sensed beings), Samvukā (Helix), Sippisāmpudā Samputarūpaka śuktayal (pearl or shells), Caṁdanā (Caṁdanakāḥ = Akṣāḥ = a kind of two-sensed beings living in water and on land)⁵¹ and sammuddalikkhā (sea-leeches ? a kind of two-sensed being which live in the sea) and others like them.⁵²

All of them live in a part of the world only, they do not live everywhere.⁵³ All of them are Saṁmūrcchima animals (asexually reproduced animals) and Napumīsakas (of third sex). There are seven lakh species and birth-places of these developed and undeveloped two-sensed animals.⁵⁴ The duration of life of these animals is twelve years at the utmost, the shortest is less than a muhūrta.⁵⁵

Life of Two-sensed Animals :⁵⁶

It appears from the study of āhāraparyāpti, śarīra-paryāpti, ucchvāsa-nihsvāsa paryāpti, etc. of these animals that among the two-sensed protozoa, single-celled animals, there is some division of labour within the single cell of these beings, but the cell functions as a unit to perform the activities associated with their life, such as, taking of food and digestion, formation of body, respiration, circulation, excretion, locomotion and reproduction. To carry out these functions many two-sensed animals have evolved specialized organells-cilia or flagella for movement, vacuoles, neurifibrils, eye-spots and so on as suggested by their names and identification⁵⁷ in the light of modern Biology.

Most of the species of two-sensed animals (protozoa) are microscopic, although a few are big enough to be seen with the naked eye. Some are shapeless “blobs of protoplasm”; others are elaborately and geometrically patterned. They may have internal skeletons or external skeletons, or protective houses, e. g. Śāṅkha (Conchifera), Śamvuka (Helix)⁵⁸ Kukṣīrmi⁵⁹ of Jaina Biology may be identical with Amaeba

51. Śāṁbūka belongs to the group of Mollusca.

52. Jīvavicārvṛtti, v. 16. They are called Akṣha in the Vernacular (Samayabhāṣā).

53. Pañnavāṇa 1.56, p. 27.

54. Uttarādhyayna Sūtra 36.130.

55. Pañnavanā 1.56.

56. Uttarādhyayana Sūtra 36.132.

57. Tattvārthādhigama Sūtra, II. 24,

58. e. g. Kucchikimiyā, Neura, Gaṇḍūpādā (T.S.V. 24), Jaloyā, Śāṅkhā, Sottiyā, Nāmdiyavattā, Śamvukka, etc. See Pañnavanā, 1.56

59. Pañnavanā, 1.56

proteus of modern Biology "which consists of a clear mass of shapeless, naked, gelatinous protoplasm, containing a nucleus and protoplasmic granules".⁶⁰

"Amaeba belongs to the class Sarcodin (flesh like) containing many other protozoa, all of which move about by means of pseudopods. Some of them, such as, the species causing amebic dysentery in man are parasitic".⁶¹

Some of the two-sensed animals may be identified with a second class of protozoa, the ciliata, typified by paramecium, which has a definite and permanent shape—clearly round in front and pointed in the rear due to sturdy, though flexible outer covering secreted by the cell, some of them with suctarians—a third class of protozoa, very closely related to the ciliates, some of them with the Sporozoa (Spore formers)—a fourth class of protozoa, having no special method of locomotion and are parasitic, e. g., germs of malaria, and some of them with the Flagellata—the fifth class of protozoa.

Some of the two-sensed animals may be compared with the phylum porifera or Sponges, coelenterates and (Tennophoros, Phylum Platyhelminthes (flatworms which live in both fresh water and saltwater, creeping over rocks, debris and leaves).

Flukes and tapeworms (Trematida and Cestoda) are two kinds of flat worms. Tapeworms are long, flat, ribbon like animals; some species of which lives as adults in the intestines of probably every kind of Vertebrate, including man, e.g. Kuksikrmi.⁶²

Besides other two-sensed animals represent the simplest animals which illustrate the organ system level of organization. None of them is parasitic to man and animals, while others may be identical with the Phylum Nematoda, made up of round worms, living in the sea or fresh water or in the soil or in other plants or animals as parasites, e. g. hook worms, etc. and also with the Rotifera (wheel-animals), the aquatic, microscopic worms and the Gastrotricha, aquatic worms which have no crown of cilia, others may be identified with the Bryozoa or moss animals, living in colonies that superficially resemble those of coelenterates and some with the Brachiopodaphylum characterized by lophophore. All brachiopods live in the sea like Samuddalikkha.⁶³

60. Ibid

61. Biology, p. 193.

62. Pannavanā 1.56

63. Pannavanā, 1.56 See Biology, pp. 193-206.

(Second Section)

The Higher Invertebrates.

The Higher Invertebrates, e. g. Nūpuraka (Annelids), Gaṇḍūpada (arthropods), Śaṅkha (conchifera), Śuktika (pearl), Śambuka (Helix), mouth and anus, a muscular gut, a well developed circulatory system and a true coelom, a cavity within the mesoderm lined by peritoneum.

Some of the two-sensed animals, namely, Apādika (Vermes)¹ without lateral appendages, Scolecides), Nūpuraka (ring-like, with pendants Vermes with unsegmented lateral appendages, Annelids), Gaṇḍūpada (Knotty legged, Arthropoda) including crustacea, (crabs), Myriapoda, etc. and Śaṅkha (Conchifera, Lamelli-branchiata), Śuktika (Pearl mussel, Lamelli-branchiata), Śambuka, (Helix) and Jalūkā (Leeches Annelids)² and some forms of Mollusca come under the category of the Higher Invertebrates.

Besides, some of the three-sensed and four-sensed animals of Jaina Biology mainly fall under the species of the Higher Invertebrates.

According to modern Biology, the Higher Invertebrates comprise the Annelids, Arthropods, Molluscs and Echinoderms³.

“Of these four-phyla, only the arthropods are very successful terrestrial animals. It is true that the earth worm is a terrestrial animal, but most annelids are marine; there are a few land snails, but most molluscs (Śambuka) live in the sea; all the echinoderms are marine”⁴ “Of the five classes of arthropods, one, the crustacea – crabs, lobsters, and so on – is largely marine, but the other four insects, spiders, centipedes and millipedes are mostly territorial”⁵.

1. Biology. p. 209.

Paññavānā 1.56. ; Tattvārthādhigama Sūtra II. :4.

2. Paññavāna 1.56.

: Tattvārthādhigama Sūtra. II. 24.

“Tad yathā Kṛmyādinām Apādikanūpuraka – Gaṇḍūpada – Śaṅkha – Śuktika-śambuka – Jalūkā – prabhṛtinām, etc.”

3. Biology, p. 209.

4. Biology. p. 209

5. Ibid.

Knotty / legged two-sensed animals (Gaṇḍūpada)

(Crustacea. Myriapoda. etc. of Arthropoda) come under the Higher Invertebrates, T.S. II. 24. The Higher Invertebrates-Insects /, (such as, Pipilikā (Ants.) etc. are mentioned as the three-sensed animals, spiders (Nandyāvartas) as four-sensed animals and Centipedes (śatapadi) as three-sensed animals in Jaina Biology, see Tattvārthādhigama Sūtra II. 24.

Three - sensed Animals - the Higner Invertebrates.

Animals with three organs of sense⁶ (touch, taste and smell) are of two kinds, viz. subtile and gross ones. Both are either fully developed or undeveloped.⁷ They are as follows :

Ovaiyā (Upacikā - Bugs, Hemiptera), Rohiniyā (Red ants, Formicidae, Hymenoptera), Kunthu (Fleas, Hemimetabola, a kind of insect-animalcules), Pipiliyā (Ants - Formicidae, Hymcuoptera), Uḍḍāṁsagā (a kind of bugs), Uddehiyā (white ants), Ukkaliyā (a three - sensed being), Uppāyā (Spring - tails, Aptera, Ametabola), Ukkaḍā (a kind of three - sensed animals), Taṇahārā (plant - lice), Kāṭṭhahārā (Termites, a kind of white ants - Neuroptera, Hemimetabola), Māluyā (a kind of three - sensed insects), Pattahārā (leaf-lice sucking the sap of the leaf), Taṇavim̄tiyā (a kind of three - sensed animals parasites in grass), Pupphavim̄tiyā (a kind of three - sensed animals parasites in flower), Phalavim̄tiyā (a kind of three - sensed animal parasites in fruit), Biyavim̄tiyā (a kind of three - sensed animals parasites in seed), Tedūraṇamajjiyā (a kind of three - sensed animals parasites in Teduraṇa), Tausamim̄jiyā (cucumber - seed weevils and lice), Kappāsaṭṭhisamim̄jiyā (Cotton - seed weevils and lice), Aptera, (Ametabola), Hilliyā (a kind of three - sensed animals), Jhilliyā (a kind of three - sensed animals), Pāhuyā (a kind of three - sensed animals), Subhāgā (a kind of three - sensed animals), Sovacchiyā (a kind of three - sensed animals), Suyavim̄tā (a kind of three - sensed animals), Imdikāiyā (a kind of three - sensed animals), Imdagovayā (a kind of three - sensed animals), Urulūm̄cagā (a kind of three - sensed animals), Kotthalavāhagā (a kind of three - sensed animals), Jūyā (Yūkā = louse), Hālahalā (a kind of three - sensed animals), Pisuyā (a kind of three - sensed animals), Tidugā⁷ (a kind of three - sensed animals), Satāvarī (a kind of three - sensed animals), Satavāiyā (Satapādikā, centipeds), Gomhī, (a kind of three - sensed animals), Hatthisom̄dā (a kind of three - sensed animals), and others like them.⁸

There are eight lakh varities and birth-places, etc. of these three - sensed animals - developed and undeveloped.⁹ Some of these three - sensed animals, namely, Kunthu (hemiptera), Pipilika (Ants - Formicidae),

6. Uttarādhyayana Sūtra 36.136; Paṇṇavaṇā 1.57 ; Tattvārthādhigama Sūtra II. 24.4
Uttarādhyayana 36.136.

7. Tindugās shining like lead, originate in the kernel of the cotton seed.

8. Paṇṇavaṇā 1.57.1.

;Uttarādhyayana Sūtra 36. 137-138 ; Tattvārthādhigama Sūtra, II. 24

9. Paṇṇavaṇā Sūtra 1.57.2.

Trapusamimjagā and Kārpāsāsthika (cucumber-and cotton weevils and lice = Aptera, Ametabola), Śatapadī or Śatapādikā (centipedes) and Utpatāka (Spring-tails, Aptera - Ametabola), Tṛṇahārakā (Plant lice) and Kāṣṭhahārakā (Termites = white ants = Neuroptera), Hemimetabola belong to the Arthropod group of the Higher Invertebrates. The Arthropods are very successful terrestrial animals, e.g. fleas, the centipedes, insects etc.

As pointed out, some of the two-sensed animals come under the category of the Annelids and Mollusca, e.g., Nūpuraka (earth worm) and Jalūkā (leeches) fall under the species of the Annelids, while Śaṅkha (Conchifera), Śuktika (pearl-mussel) and Śambuka (Helix) belong to the groups of Mollusca.

All of the three-sensed animals live in part of the world only, they do not live everywhere.¹⁰ They live in both land and water. But mostly they continue their life in water, as it is stated that they live in Agaṇa (a small water place), Talaga (pond), Nadī (river), Daha (Lake), Vāvī (a large oblong pond), Pukkhariṇī (pond), Dihiyā (big tank), Gumiṇaliyā (a large water-place), Sare (Lake or water-pool), Sarapāṇtiyā (rows of such pools), Bila (hole or pit), Bilapāṇtiyā (rows of holes), Ujjhara (fountain or spring), Nijjhara (waterfall or pits), Cillala (a kind of watery place), Pallala (a kind of Jalāśaya), Vappiṇa (a kind of Jalāśaya), Diva (island), Samudda (seal) in all Jalāśyas (marine places) and Jalaṭṭhāṇas (watery places).¹¹

They live in the innumerable parts of the Universe with regard to birth, etc.¹²

Four-sensed Animals

Four-sensed animals¹³ which also belong to the category of the Higher Invertebrates are of two kinds, viz. subtile and gross ones. Both are either developed or undeveloped.¹⁴ They are as follows :

Andhiyā (a kind of four-sensed animals), Potṭiyā (gnats), Daṁsā (gad-flies) Netṭiyā (a kind of four-sensed animals), Macchiyā (Makṣikās, flies), Magamigakiḍi (Kiṭa-butterflies and moths), Lepidoptera, Holometabola, Masagā (Mosquitoes), Payamīgā (Patangas-grasshoppers and

10. Uttarādhyāna Sūtra 36.139.

11. Pañnavāṇā Sutta 2.164. (Sthānapada).

12. Pañnavāṇā II, 164.

13. Ibid.

14. Uttarādhyāna Sūtra 36.145; Pañnavāṇā 1.58,1.
; Tattvārthādhigama Sūtra II. 34.

locusts, Hemimetabola), Kukkuḍa (a kind of four-sensed animals), Nandāvattā (spiders), Arachnida, Arthropoda, Vicchiya, Vṛścika, (Scorpion), Simgiriḍa or dī (a kind of four-sensed animals), Kīṇhapattā (a kind of four-sensed animals having black colour), Nilapattā (a kind of four-sensed animals having blue colour), Lohiyapattā (a kind of four-sensed animals having red colour), Haliddapattā (a kind of four-sensed animals having yellow colour), Sukkilapatta (a kind of four-sensed animals having white colour), Cittapakkha (or Cittapatta) (a kind of four-sensed animals), Vicittapakkha (a kind of four-sensed animals having variegated wings), Obhamjaliyā, (or ohimjaliyā), (a kind of four-sensed animal), Jalacariyā (or Jalakāri, a kind of four-sensed aquatic animals), Gambhīra (a kind of four-sensed animal), Niniyā (or Niyayā, a kind of four-sensed animal), Tamītavā (or Tambagaiya, a kind of four-sensed animal), Acchila (a kind of four-sensed animal), Māhaya (or Sāhaya, a kind of four sensed animal), Aechiroḍa (a kind of four-sensed animal), Acchiveha (a kind of four-sensed animal), Sāramga (Hornets, Hymenoptera, Holometabola), Neulā (a kind of four-sensed animals), Dolā (a kind of four-sensed animals), Bhimgiriḍi, (Crickets), Bhamarā (bees), Virali or Bharilī (a kind of four-sensed animal), Jarulā (a kind of four-sensed animal), Varaṭa (Waspa),¹⁵ Tothā (a kind of four-sensed animals), Vicchuta a kind of Scorpions) Pattavicchuya (a kind of scorpions living on leaf) Chāṇavicchuya (a kind of scorpions), Jalavicchuya (a kind of scorpions living in water), Piyaṅgālā (a kind of four-sensed animals), Gomayakīḍagā (cowdung worms), and others like them.¹⁶

According to Jaina Biology, they are all Samūmurechima Napum-sakas¹⁷.

Their longest life-duration is six months and the shortest is an antarmuhūrata¹⁸. They mostly live in water, land, etc. like the three-sensed animals.¹⁹

Some of these four-sensed animals, four senses having (touch, taste, smell and sight), e.g. Bhramara (Bees Hymenoptera), Poltika (gnats), Makṣikā (flies), Maśakas (Mosquitoes-Holometabola, Diptera) Vṛścika and Nandyāvarta (Scorpions and Spiders, Arachnida, Arthropoda), Kīṭa

15. Uttarādhyayana Sūtra, 36.145.

16. Uttarādhyayana Sūtra, 36.146-149; Pañṇavāṇa, 1.58.1, Tattvārthādhigama Sūtra II. 34.

17. Pañṇavāṇa, 1.58.1.

18. Uttarādhyayana Sūtra, 36.151.

19. Pañṇavāṇa Sūtra II. 165 (Sthanapada).

(Butterflies and Moths—Lepidoptera, Holometabola), Patangas (Grasshoppers and Locusts—Orthoptera Hemimetabola), definitely come under the Category of the higher Invertebrates. Spiders, scorpions, grasshoppers, moths, butterflies, colonial insects—bees etc. belong to the Arthropoda group of the Higher Invertebrates of modern Biology.

CONCLUSION

Among the most familiar invertebrate animals are the earth worms (Nūpurakas)—the members of the Phylum Annelid. This word 'Neuraya' or 'Nūpuraka' (Annelid) which means (ringed) refers to the fact that the body of the worm consists of a series of rings or segments. According to modern Biology, "Both the internal organs and the body-wall are segmented so that each animal is made of about one hundred more or less similar units, each of which contains one or a pair of organs of each system²¹."

The animals that make up the Arthropoda Phylum are the most successful, biologically of all animals, for, according to modern Biology, "there are more of them (about 870,000 species are known, of which some 800,000 are insects), they live in a greater variety of habitats and can eat a greater variety of food than the members of any other phylum".²¹ In Jaina Biology there appear to be six kinds of Arthropoda, viz. (1) Trilobita (marine arthropoda, Jalavicchuya, Jalacariya, etc.,) (2) the crustacea, e. g. crabs, etc., (3) the Centipedes, (Śatapadī) which are fast moving carnivorous forms, some of which can inflict a painful bite; the Millipedes, which are slower-moving plant-eaters (Kaṣṭhahāraka, Ṭṛṇapatraka, etc.) (5) the Arachnids, including spiders (Nandyāvarta), Scorpions (Vṛścika), etc. and (6) the Insects (Kunthu, etc.). The characteristics of these arthropods are their paired jointed appendages which are used in a variety of ways, as swimming paddles, walking legs, mouth parts, etc. "All the arthropods have segmented bodies covered by a hard external coat of cuticle secreted by the underlying epithelium".²²

The Mollusca which includes snails (śambuka) etc. is the second largest of all the animal phyla according to modern Biology, with its 80,000 species.²³

20. Biology, p. 210.

21. Ibid., p. 214.

22. Biology, p. 214.

23. Biology, p. 222.

The echinoderms (Spiny-skinned) which include the sea stars (Asteroidea), sea urchins (Echinoidea), sea cucumbers (Holothroidea), serpent stars (Ophiuroidea) and sea lilies (Crinoidea) are a group of animals radically different from all other invertebrates. The reference to some sea animals having four sense-organs in Jaina Biology may suggest their identification with Echinodermata.

The foregoing description of the two-sensed, three-sensed and four-sensed animals (i. e. the Lower Invertebrates and the Higher Invertebrates) as given in the Jaina works does not exhaust the great variety of the animals. In addition to these phyla, there are other groups of invertebrate, sometimes put in phyla of their own, sometimes classified under other phyla, e.g. some of the two-sensed animals, namely, Apādika (Vermes) without lateral appendages, Scolecides, Nūpurka (ring - like, with pendants, Vermes with unsegmented lateral appendages, Annelids), Gaṇḍūpada (Knotty-legged Arthropoda, including crustacea, Myriapoda, etc.) and Saṅkha (Conchifera, Lamelli branchiata), Śuktika (pearl mussel, Lamelli branchiata), Śamvuka (Helix) and Jalūkā (Leeches - Annelids) and some form of Mollusca have been classified under the phyla of the Higher Invertebrates.

(Third Section)

The Phylum Chordata : Five - sensed Animals

The Phylum Chordata :

The animals, (man and higher animals) having five sense organs¹ fall under the class of the Phylum Chordata of modern Biology, which consists of the sub-phylum, Vertebrate animals, such as, fishes (mucchā) amphibia (frogs - maṇḍūka)², reptiles (parisappas),³ birds (pakkhīs)⁵ and mammals including man (maṇussa).⁶ Its members are distinctive in having a notochord, a dorsal, hollow nerve cord (Snāyu) and gill slits.⁷ The fishes, amphibia, reptiles, birds, and mammals make up the classes of the sub-phylum Vertebrata, characterized by a cartilaginous or bony vertebral column.

The Vertebrates :

They are distinguished from the types of lower chordates or other lower animals by the possession of an internal skeleton of cartilage or bone that reinforces or replaces the notochord. "The notochord is a flexible, unsegmented, skeletal rod, extending longitudinally in all chordates. It is the only skeletal structure present in the lower chordates ; but in the Vertebrates segmental bony or cartilaginous Vertebrates surround the notochord".⁸ "In the higher Vertebrate the notochord is visible only early in development ; later the Vertebrae replace it completely. Vertebrates have a bony or cartilaginous brain case ; the cranium, which encloses and protects the brain, the enlarged anterior end of the dorsal, hollow nerve cord".⁹

1. Uttarādhyayana Sūtra 36.155; 170, etc. Pañṇavaṇā Sūtra 1.61. ff. ; Tattvārthādhigama Sūtra II. 34.
2. Uttarādhyayana Sūtra 36.172 ; Pañṇavaṇā Sutta 1. 62-63. ; Tattvārthādhigama Sūtra II. 34.
3. Bhagavatī Sūtra 12. 8. 446.
4. Uttarādhyayana Sūtra 36. 181. ; Pañṇavaṇā 1, 76, ff. ; Tattvārthādhigama Sūtra II. 34.
5. Uttarādhyayana Sūtra 36. 187. ff. ; Pañṇavaṇā Sūtra 1, 86. ff. ; Tattvārthādhigama Sūtra II. 34.
6. Uttarādhyayana Sūtra 36. 180, 194. ; Pañṇavaṇā Sutta 1.70, 71, 72, 73, 74, 92. ; Tattvārthādhigama Sūtra II. 34.
7. Biology, p. 228.
8. Biology, p. 230.
9. Biology, p. 230

Vertebrates have a pair of eyes (cakkhu)¹⁰ that develop as lateral outgrowths of the brain. Invertebrate eyes, such as, those of insects (pipilikā, Kunthu, etc.) may be highly developed and efficient, but they develop from a folding of the skin.¹¹ Another vertebrate characteristic is a pair of ears (Sōeimidiya), which in the lowest vertebrates are primarily organs of equilibrium.¹²

The circulatory system of vertebrates is distinctive in that the blood (Śoṇita)¹³ is confined to blood vessels (dhamanīs and śirās) and is pumped by a ventral, muscular heart (hiyaya)¹⁴. The higher invertebrates, such as, arthropods and molluses (śuktika and śaṅkha, etc.) typically have hearts but they are located on the dorsal side of the body according to modern Biology and “pump blood in the open spaces in the body called a hemocoel. Vertebrates are said to have a closed circulatory system; arthropods and molluscs have an open circulatory system; for the blood is not confined solely to tubular blood vessels”.¹⁵

Classes of the Sub-phylum Vertebrata :

The five-sensed animals of Jaina Biology can be classified into eight classes of the Subphylum Vertebrata of Modern Biology, viz. (1) the Agnatha – the jawless fishes (matsa), e. g. Saṅhamaccha, lamprey eels, etc. (2) the Placodermi – the jawed fishes, (3) the Chondrichthyes, e. g. sharks (timi ?) with cartilaginous skeletons, (4) the Osteichthyes – the bony fishes, e. g. Rohiyamaccha (5) the Amphibia (frogs, Maṇḍūka), (6) the Reptilia (parisarpas) – lizards, snakes, turtles and alligators, (gṛhagolikā, Sarpa = ahi, Kacchapa and Godhā), (7) the Avesbirds (pakṣis) and (8) the Mammalia – the warm blooded fur bearing animals that suckle their young sthalacara catuṣpada prāṇis, Apes and man).

In Jain Biology the five-sensed animals lower and higher vertebrates are first classified into two main classes of the subphyla on the basis of their mode of origin, viz. (1) Sammūrcchima (generatio aequivoca)

10. Bhagavatī Sūtra 16. 1. 566 ; Tāṇḍuveyaliya 8, 87. ; Pañṇavaṇā Sūtta, 191. Indriyapada Bhagavatī 2.4.99 (cakkhu)
11. Tvac. (Skin) ; Bhagavatī Sūtra 16.1 566, Tandulaveyāliya 3, p. 7; Pañṇavaṇā Sutta 191, Indriyapada ;
12. Biology, p. 231.
13. Ācārāṅga Sūtra II, 4. (śonita) ; Sūtrakṛtāṅga II. 2.18 ; Bhagavatī Sūtra 1.7.61 ; Tandulaveyāliya 2. P. 6 ; Kalyāṇakāraka) ; Ugrādityacaryā, V. 7. p. 31 (Rakta) ; Tandulaveyāliya 2, p. 6. ; Kalyāṇakāraka, vv. 2, 3, 3rd paricchida, p. 30.
14. Sūtrakṛtāṅga II. 2.18.
15. Biology, P. 231

and Garbhavyutkrāntika (those which are born from the womb).¹⁶ Next they are divided into three groups on the basis of their habitats, viz. (1) Jalacara (aquatic), (2) Sthalacara (terrestrial) and Nabhadara or Khecara (aerial).¹⁷ Matsya (fishes), Kacchapas (tortoises), Grāhas (crocodiles), Makara (a kind of Sea monster – the emblem of the goddess Gangā) and Śiśumāra (Dolphin or Gangetic porpoise Cetacea) are the five kinds of Jalacaras (aquatic animals).¹⁸

The longest duration of the life of the aquatic animals is one crore of Pūrvas: the shortest is less than one muhūrta.¹⁹

Sthalacaras (terrestrial animals) are of two kinds, viz. Catuśpadas (quadrupeds) and Parisarpas (reptiles),²⁰ quadrupeds which come under the subphylum of Mammals will be discussed later on in details. Here it is to be known that they are of four kinds, viz. (1) egakhurā (Solid-ungular animals), e.g. horses, etc., (2) dukhurā (Biungular animals), e. g. cow, buffalo, etc., (3) Gaṇḍipadā (Multiungular animals) e. g. elephant etc. and (4) Saṇṇapphadā (Animals having nails),²¹ e. g. lions, etc.

Parisarpas (reptiles) are of two classes : (1) Bhujaparisarpas (those which walk on their arms), e. g. Gṛhagolikā (lizards), etc. and Uraḥparisarpa those which move on their breast, e. g. snakes, etc.²²

The longest duration of the life of the terrestrial animals is three palyopamas ; the shortest is less than one muhūrta.²³

The longest duration of the life of terrestrial animals continuance i. e. the continuous birth in the same type or body is three palyopamas plus from two to nine krores of pūrva years ; the shortest is less than one muhūrta ”.²⁴

16. Bhagavatī Sūtra 12.8.460 (Golaṁgūla – ape) ; Jivābhigama Sūtra, 1.33. ; Uttarādhyayana Sūtra 36. 170.
17. Bhagavatī Sūtra 7.5.282 ; Uttarādhyayana Sūtra 36.171 ; Paṇṇavaṇā Sūtra, 1.61, p. 29.
18. One Pūrva year consists of 7560 millions of common years.
19. Uttarādhyayana Sūtra 36.175
20. Uttarādhyayana Sūtra, 36.179. Paṇṇavaṇā 1.69.
21. Uttarādhyayana Sūtra, 36.179–180. ; Paṇṇavaṇā Sūtra 1.70
22. Uttarādhyayana Sūtra 36.181 ; Paṇṇavaṇā 1.76.
23. Uttarādhyayana Sūtra 36.183.
24. Uttarādhyayana Sūtra 36.184. “Paliovamājīm tiṇṇi u,ukkosenṇa viyāhiyā / āuṭhii thalayarāṇām, aṁtomuhuttāṁ jahaṇṇiyā //

Nabhacaras (Aerial Animals)

Aerial animals are of four kinds, viz. (1) Carmapakṣin (those with membranous wings),²⁵ e.g. bat (valguli), (2) lomapakṣin (those with feathered wings), (3) Samudgapakṣin (those with wings in the shape of a box)²⁶ and Vitata pakṣin (those which sit on outspread wings)²⁷.

The longest duration of the life of aerial animals is an Asaṅkheyabhāga (innumerable part) of a palyopama; the shortest is less than one muhūrta.²⁸

The longest life duration of the aerial animals' continuance i. e. the continuous birth in the same type of body is an Asaṅkheyabhāga of a palyopama plus from two to nine krōs of pūrva years; the shortest is less than one muhūrta, according to the Pañṇavaṇā Sutta.²⁹

It is to be noted here that Bhujāṅga and Uraga³⁰ (or Bhujaparisarpa and Uraḥparisarpa) mean reptiles in popular sense, but here Bhujāṅga (or Bhujāṅga) is evidently oriparous limbed animals (limbed reptiles and Batrachians) and "not creatures whose movements are crooked or in the form of a bent bow".³¹

Uraḥparisarpa or Uraga means apodal reptiles, including snakes (ophidae), Carmapakṣa-pakṣis, the so-called birds with leathern wings, (Bats, Chiroptera) e.g. Valguli (flying-fox), Pakṣivirāla (flying-cat, Microchiroptera) and Jalūkā (apparently meaning blood-sucking Bats or Vampires), are included in the species of birds, (Pakṣī) because they are homologous and similar in structure and function, but they should be placed in the group of the Mammals as they have all characteristics of the Mammals. Catuśpadas which fall under the category of the Mammals is identical with the Vertebrata.

Fishes :

According to Jaina Biology, there are many kinds of fishes, such as, Saṇhamacchā (kind of smooth scaleless fishes; they may be

25. Uttarādhyayana Sūtra, 36.187; Pañṇavaṇā 1.86.
26. These interesting birds are said to live outside the Mānushottara or world inhabited by men.
27. Uttarādhyayana Sūtra 36.187; Pañṇavaṇā 1.86.
28. Uttarādhyayana Sūtra 36.190.
29. Ibid. 36.191.
30. Tattvārthādbigama Sūtra II; 34.
31. Positive Sciences of the Ancient Hindus, p. 19.

identified with Jawless fishes – the living lamprey eels),³² Khavallamacchā (a kind of fish – cassyta filiformis), Jugamacchā (a kind of fish) Vijjhīdiyamacchā (kind of fish), Halimacchā (Hali matyas – a kind of bony fish), Maggarimacchā (a kind of fish, it may be identified with the scaleless Māgur matsya), Rohiyamaccha (Rohita matsya = Labeo rohita, a scaly long fish of reddish tint), Halisāgarā (Ilisāgarā, a kind of scaly, bony fish in Bengal), Gāgarā (a kind of fish, it may be identified with Bengal's riverine ghāgrāmatsya), Vaḍā (a kind of fish, it may be identified with Vaṭaka – scaly, riverine, disc-like globular fish), Vaḍagarā (a kind of fish of the same kind), Timi (whale) Timiṅgilam (a large fabulous fish), Nakka (Nakra, a kind of fish or Shark or crocodile ?), Tamḍulamacchā (a kind of fish), Kaṇikkāmacchā (kind of fish), Sālisacchiyamacchā (a kind of fish), Laṁbhaṇamacchā (a kind of fish), Paḍāga (a kind of fish), Paḍāgāti-paḍāgā (a kind of fish) and others like them.³³

It appears from the study of this list of fishes that some of them are jawless, scaleless fishes, e.g. sañhamaccha, some are jawed cartilaginous fishes, e.g. shark, etc., some are bony, scaly fishes, e.g. Rohita (Labeo Rohita), etc.

Kacchabhbā (Tortoises).

There are two kinds of tortoises, viz. Aṭṭhikacchabha (Bony tortoise called Kālikacchapa in Bengal) and Māṁsakacchabha (fleshy tortoise called Chimakacchapa in Bengal)³⁴.

Gāhā (Crocodiles)

There are stated to be five kinds of Gāhā, viz. Dili, Vedhalā, Muddhayā, Pulagā and Simāgarā.³⁵

Magarā (a kind of Sea-monster regarded as the emblem of Kāmadeva or Gangā) :

There are stated to be two kinds of Magara, viz. Sonidamagara and Maṭṭhamagara.³⁶

32. They are cylindrical fish, up to 3 feet long, with no jaws or paired finsh, they may be lamprey eels.
33. Paṇṇavaṇā 1.63
34. Paṇṇavaṇā 1.64.
35. Ibid 1.36. It is true that there are a few varieties of crocodiles. A kind of fish-eating crocodile is found in Bangladesh, while the man-eating crocodiles are also found in abundance in the Sundarban rivers and other small rivers in Bangladesh.
36. Ibid. 1.66

Sumsumāra (Dolphins)³⁷

Śumśumāra is of one variety only.

The Jalacaras (aquatic animals) are classified into two groups, viz. Saṁmūrcchima (those which are asexually reproduced) and Garbhavyutkrāntika (born from the womb). All the Saṁmūrcchimas are Napuṁsakas (belong to the third sex), while Garbhavyutkrāntikas are of three kinds, viz. Itthī (female), Purisā (Male) and Napuṁsaka (that of third sex). Of these aquatic animals-developed and undeveloped there are 13 1/2 lakh varieties and birth places of them.³⁸

Amphibia (MAṄDUKAJĀTI OR DADDURAJĀTI).

The land Vertebrates - Maṇḍukas or Dadduras (frogs) represent the amphibian animals. Frogs and toads are highly specialized for hopping. Although the frogs are land animals and can live in comparatively dry places, they must return to water to reproduce. "Eggs and sperms are generally laid in water and the fertilized eggs, nourished at first by the yolk, develop into larvae or tadpoles. These breathe by means of gills and feed on aquatic plants. After a time the larva undergoes metamorphosis and becomes a young adult frog or salamander, with lungs and legs"³⁹.

A number of frogs, toads and salamanders have skin glands that secrete poisonous substances, for this reason they are perhaps called Maṇḍukajāti āśīviṣa,⁴⁰

Parisarpas (Reptiles) : Sthalacaras :

The class-parisarpa (Reptilia)⁴¹ is a living species of true land forms. They need not return to water to reproduce as amphibian must. They are oviparous animals. "The bodies of reptiles are covered with hard, dry, horny scales which protect the animal, from desiccation and from predators".⁴² The reptiles described in the Āgamas are of two kinds,

37. Pañṇavaṇā Sutta 1.67.

38. Ibid. 1.68. 1-4.

39. Bhagavatī Sūtra 8.2.316 ; 12.8.460 ;

; Maṇḍuke hari-śātūra - plava - bhika - plavaṅgamāḥi varṣābhūḥ plavagāḥi śūluta jihva - vyaṅga - dardurā / (1354) ; Abhidhāṇa cintāmoni, Hemacandra, p. 38 ; Maṇḍukka - Maṇḍayati ; Varsāsamayam - Maṇḍi - Bhekejalajantu bhide / praśnāvya karaṇa / Āśrayadvāra, vide Abhidhāṇa Rājendra, p. 23 (y) Vyavahāra 1.6, Pra. 1.6 Bhā. 1. Biology, p. 234.

40. Bhagavatī Sūtra 8.2.316

41. Uttarādhyayana Sūtra 36.181 ; Pañṇavaṇā Sutta 76 ;

42. Biology, p. 243.

viz. Urahparisarpa (those which move on their breast, e.g. snake) and Bhujaparisarpas (those which walk on their arms, e. g. lizards, etc.).⁴³ Both are again of many kinds.⁴⁴

Urahparisarpas :

They are of four kinds, viz. Ahī (snake), Ahigarā (a kind of snake), Āsāliyā (a kind of reptiles Urahparisarapas) and Mahoragā (a kind of reptiles Urahparisarapas).⁴⁵

Ahi (Snake):

Ahī is of two kinds, viz. Davvikarā⁴⁶ and Maulino.⁴⁷

Davvikarā is of many kinds such as, Āśviṣā, (those having poison in teeth), Diṭṭhiviṣā (those having poison in vision), Uggavisā (those having deadly serious poison), Bhagavisā (those having poison in body), Tayāvisā (those having poison in skin), Hālāvisā (those having poison in saliva) Ussāsavisā (those having poison in inhaling air), Nissāsavisā (those having poison in exhaling air,) Kāṇhasappā (Kṛṣṇasarpā=black snake-cobra Naja Tripurdians), Sedaspappā (a kind of snakes), Kāodara (a kind of snakes), Dajjhapupphā (Dagdhapuṣpā, a kind of snakes), Kolāhā (a kind of snakes), Melimiṁda (a kind of snakes) and others like them.⁴⁸

Maulino (Mukulina) (Hoodless Snake)

There are many kinds of Maulino, such as, Divvāgā, Gonāsā, Kasāhiya, Vaiulā Cittaliṇo Maṇḍalino Mālino, Ahī, Ahisalāgā, Paḍāga and others like them.

Avagara (Boidae)

It is of one kind only (egāgāra).⁴⁹

43. Uttarādhyayana Sūtra 36.181 ; Pañṇavāṇā 1.76. ; Tattvārthādhigama Sūtra 2.34.

44. Uttarādhyayana Sūtra 36.181

45. Pañṇavāṇā 1.77.

46. Darvīkaras are mentioned in ḡuṛuta - Nāgārjuna (Kalpasthāna, ch. IV) of the five Darvīkaras (Kṛṣṇasarpa, Mahākṛṣṇa, Padma, Mahāpadma, śaṅkapāli - Naja. Tripudians, Naja Bangarus are hooded swift in their movement diurnal in their movement; diurnal in their habits, bear on their hoods or their bodies the marks of chariot - wheel, ploughs, umbrellas rhombs; or cross-bands, goads, etc., PSAH. p. 186.

47. Pañṇavāṇā 1.78,

48. Ibid. 1.79.

49. Pañṇavāṇā 1.80. Ibid. 181

Āsāliyā :

They are born and live in islands, forts, villages, towns, Nigamas (a city or market places), Khedas (small towns), Karbaṭas (market-towns or villages), Maṇḍavas (temples), Doṇamuhas (the ends of a valley), Pattanas (towns or cities), Āgaras, (mines), Āsamas, (hermitages) Saṁvāhas (parks for recreation or market-places), and capitals (Rāyahāṇī). They are saṁmūrcchima prāṇīs. They are in the minimum innumerable part of a cubic finger in length and 12 Yojanas in the maximum, like that in breadth and depth. On the destruction of islands, etc. they rise up by making the earth burst forth and die in an antarmuhūrtā.⁵⁰

Mahorgā :

Mahoragā (Reptiles living in the external islands and seas)⁵¹, are of many kinds, such as, (1) Some are one cubic finger in length (2) Some are aṅgulapuhattiyā (two-nine cubic fingers in length), (3) (3) Some are one viyatthi (thumb finger to small finger in length), (4) Some are viyatthipuhattiyā (two-nine fingers in length), (5) Some are one rayaṇī (one cubit=18" in length) (6) Some are rayaṇī-puhattiyā (two to nine rayaṇīs in length), (7) Some are one kucchi, i.e. two cubits) in length), (8) Some are Kucchi-puhattiyā (two to nine Kucchis), (9) Some are one dhaṇu (four cubits in length), (10) Some are dhanupuhattiyā (two to nine dhanus in length), (11) Some are one gāuyam (2000 dhanus in length), (12) Some are Gāuyapuhattiyā, (i.e. two to nine gauyams) (13) Some are one Yojana (14) gāuyas in length), (15) Some are Yojanasatam (one hundred Yojanas in length), (16) Some are Yojanasatapuhattiyā (two to nine Yojanaśatas), (17) Some are Yojana-śahasram (one thousand Yojanas in length), and many others like them⁵².

They are born in land but move in both water and land. They live in the external islands and seas.⁵³

They are of two kinds, viz. Saṁmūrcchima (asexually reproduced) and Garbhavyutkrāntika (sexually reproduced). All the Saṁmūrcchima are Napuṁsakas (that of third sex). Garbhavyutkrāntikas are of three

50. Ibid. 1.82

51. Paṇṇavāṇā 1.83

52. Ib d. 1.83.

It is difficult to identify them in the absence of further knowledge about them. But it is certain that a kind of snake type reptilia are found to originate in the ruins of old houses and buildings on their destruction.

53. Ibid.

kinds, viz. Itthī (female), Purisa (male) and Napuṁsaga (third sex)⁵⁴.

Of these Urahparisarpas developed and undeveloped, there are ten lakh varieties and birth-places⁵⁵ of them.

Bhujaparisarpas (Reptiles which walk on arms) :

Bhujaparisarpas are of many kinds, such as, Naula (Nakula - mangoose), Gohā (Godhā, Varanidae Lizards, Reptilia), Saradā, (a kind of Bhujaparisarpas), Sallā (porcupine on a kind of Bhujaparisarpas), Saramāthā (a kind of Bhujaparisarpas), Sārā (a kind of Bhujaparisarpas), (Gharoilā (a kind of Bhujaparisarpas), Vissambharā (a kind of Bhujaparisarpas), Mūsā (rats a kind of Bhujaparisarpas), Mañgusa (a kind of Bhujaparisarpas), Payalāiyā (a kind of Bhujaparisarpas), Chiravirāliya (a kind of Bhujaparisarpas), Jāhā (a kind of Bhujaparisarpas), Cauppāiyā (a kind of Bhujaparisarpas), and others like them.⁵⁶

They are divided into two kinds, on the basis of their mode of origin, viz. Saṁmūrcchima (asexually reproduced) and Garbhavyut-krāntikas (sexually reproduced or born from the womb). All Saṁmūrcchimas are Napuṁsakas (of third sex). Those which are Garbhavyut-krāntikas are of three kinds, Itthī (female), Purisa (male), Napuṁsaga (third sex)⁵⁶.

Of these Bhuja parisarpas - developed and undeveloped there are nine lakh varieties and birth-places, etc.⁵⁷

Catuṣpadās (Quadrupeds) :

As pointed out, they are the terrestrial mammals and there are four sub-classes of Catuṣpadas viz. Egakhurā, Dukhurā, Gaṇḍipadā and Saṇapphadā⁵⁸.

Egakhura (Solidungular Animals)

Solidungular animals are of many kinds, such as, Assā (horses), Assatarā (kind of horses or mules), Ghoḍagā (mares or a kind of horses), Gaddabha (ass), Gorakkarā (a kind of Solidungular animals), Karīdagā (a kind of solidungular animals), Sirikamīdadaga (a kind of solidungular

54. Ibid. 1.85

55. Ibid.

56. Ibid.

57. Ibid. 1.85.5.

58. Pañṇavaṇā 1.70.

animals), Avattā (a kind of solidungular animals) and others like them.⁵⁹

Dukhurā (Biungular Animals).

They are of many kinds, such as Uṭṭhā (camel), Goṇā (cows), Gavayā (Bos gaveeus-Ungulata), Rojjhā (a species of Biungular animals), Pasayā (a species of Biungular animals), Mahisā (buffalo), Miya (deer), Samvarā (a species of Biungular animals, a kind of deer), Varāhā (boars or hogs or swines), Avā (goats), Sarabhā (a kind of deer), Camarā (Yaks), Kuraṅgā (a kind of deer), Gokaṇṇā (the deer Antilope picta), and others like them.⁶⁰

Gaṇḍipadā (Multiungular Animals)

There are many kinds of Gaṇḍipadas, such as, Hatthi (elephant), Pūyanayā (a kind Multiungular animals), Mamkunahaithi (a kind of elephants), Khaggā (a kind of rhinoceroses), Gaṇḍāras (rhinoceroses) and others like them.⁶¹

Sanapphadā (Animals with incisor teeth and nails)

There are many kinds of them, such as, Sihā (lions), Vaggha (tigers), Divyā (Dipikā, a kind of tiger, leopard or panther), Taracchā (wolves), Parassarā (Panthers or a particular wild animal), Siyālā (Sṛgālās = foxes), Biḍālās (cats), Sunagā (dogs), Kokamtiya (a kind of Carnivorous animals), Sasagā (hares), Cittagā (a kind of Carnivorous animals), Cittalagā (a kind of Carnivorous animals) and others like them.⁶²

All these animals are classified into two kinds on the basis of their mode of origin, viz. Sammūrcchima (animals asexually reproduced) and Garbhavyutkrāntika (animals born from the womb). Those which are Sammūrcchimas are Napumāsakas. Those which are Garbhavyutkrāntika are of three kinds, viz. Itthī (female), purisa (male) and Napumāsaga (third sex). Of these terrestrial quadrupeds - developed and undeveloped, there are ten lakh varieties and birth - places of them.⁶³

59. Ibid. 1.71,

60. Ibid. 1.72.

61. Paññavaṇā, 1.73.

62. Ibid. 1.74. Tattvārthasūtra mentions Ḥksa (bear) after Vyāghra (tiger).

63. Ibid. 1.75. 1-4.

Pakkhi (Birds) :

Pakṣins (Birds) are characterized by the presence of feathers (Pakṣas⁶⁴, Lomas); "these decrease the loss of water through the body surface, decrease the loss of body heat, and aid in flying by presenting a plane surface to the air"⁶⁵.

Like parisarpas (reptiles) birds lay eggs and have internal fertilization, i.e. they are oviparous (aṇḍaja).^{66a} They have become adapted to a variety of environments and different species have very different types of wings, tails, beaks, feet, etc.

As pointed out, there are four species of birds, viz. Carmapakṣi (so - called birds having leathern wings - Bats, chiroptera = Valguli), Lomapakṣi (birds proper having feathered wings), Samudgapakṣi (those with wings in the shape of a box)⁶⁶ and Vitatapakṣis (which sit on outspread wings)⁶⁷.

Carmapakṣis have been included by the Jainācāryas into the category of birds on the basis of their homologous features of wings with birds proper having feathered wings. But they should be placed under the species of the Mammals, according to modern Biology, as they have feathers of the Mammals.

Carmapaksi (leather-winged birds)

Carmapakṣi are of many kinds, such as, Vagguli (bat), Jaloyā (Jalūkā, aquatic or amphibious or blood-sucking bat or vampire ?) Adilā (a kind of Carmapakṣi), Bhāraṇḍapakkhi (a species of micro-chiroptera, the horse-shoe bat ?), Jīvamjīvā, Samuddavāyasā, (sea-crows ?) Kaṇṇatiya, (a kind of Carmapakṣi). Pakkhibirali (flying cat, micro-Chiroptera etc.)⁶⁸

It is difficult to identify all of them at the present state knowledge of taxonomy.

Lomapaksi (Birds having feathered wings).

There are many kinds of Lomapakṣis, such as, Dhankā (a kind of crows), Kaṇkā (herons), Kurala (Ospreys-large birds prying on fish), Vāyasā (crows), Cakkāgā (a kind of birds), Haṁsā (ducks), Kalahaṁsā

64. Paṇṇavaṇā 1.86.

65. Biology, p. 243.

66a Tattvārthādhigama Sūtra, II. 34. (Aṇḍajānām Pakṣinām)

66. Uttarādhyayana Sūtra, 36.187. Paṇṇavaṇā 1.87.

67. Paṇṇavaṇā 1.87.

68. Paṇṇavaṇā 1.87

(a kind of ducks), Pāyahamīsā (a kind of ducks), Rāyahamīsā (Ganders), Aḍā (a kind of bird), Seḍi (a kind of bird), Bagā (Vakas, herons); Balāgā (Balākās, cranes), Parippavā (a kind of birds), Komicā (Krauñca= curlews, wading birds with long slender curved bill), Sārasā (the Indian cranes), Mesurā (a kind of birds), Maśurā (a kind of birds), Mayurā (peacock), Satavacchā (a kind of birds), Gaharā (a kind of birds), Poṇḍariyā (a kind of birds), Kāgā (Kākas, black crows), Kāmajugā (a kind of birds), Vaṁjulagā (a kind of birds), Tittirā (partridges), Vattagā (a kind migratory bird allied to partridge, esteemed as food, quail), Lāvagā (a kind of birds), Kavoyā (pigeons), Kavīñjalā (a kind of birds), Parevayā (a kind of pigeons), Cīḍagā (a kind of birds), Cāsā (a kind of birds), Kakkuḍā (wild cocks), Sugā (Śukā, parrots), Barahiṇā (a kind of birds), Madanasalāgā (a kind of birds), Koilā (Cuckoos), Sehā (Śekhā, peacocks ?), and Varellagamādi (a kind of birds) etc.⁶⁹

Samudgapaksi :

Samudagapakṣī is of one kind only. This species is not found in India, but they live in the external islands and seas.⁷⁰ It is not possible to identify this class at the present state of our knowledge of taxonomy.

Vitatatapaksi :

It is also of one kind and it lives in the external islands and seas.⁷¹

All these birds are of two classes, from the point of view of the mode of origin viz. Saṁmūrcchima⁷² (asexually reproduced) and Garbhavyutkrāntika (sexually reproduced). Those which are Saṁmūrcchimas are Napuṁsakas. Those which are Garbhavyutkrāntikas are of three kinds, viz. Itthī (female), Purisa (male), Napuṁsaga (third sex).⁷³

Of these aerial animals – developed and undeveloped, there are stated to be 12 lakh varieties and birth – places.⁷⁴

69. Paṇṇavaṇā 1.88.

70. Paṇṇavaṇā 1.89.

71. Ibid. 1.90.

72. Saṁmūrcchimas grow by assimilating the materials in their surrounding. According to a second explanation their internal organ does not fully develop.

73. Paṇṇavaṇā Sutta, 1.91'-3.

74. Ibid., 1.9'-4,

It appears from the list of birds that not all birds fly; some, such as, *haṁsas* have become adapted to a variety of environments.

In Jaina Biology the vertebrata is also sub-divided into three classes on the basis of the mode of reproduction⁷⁵ viz., (1) *Andaja*, oviparous (Pisces, Reptilia, and Batrachia), e. g. (snakes, ophidia, Reptilia), *Godhā* (Varanidae, Lizards, Reptilia), *Krikalāsa* (Chameleons Reptilia), *Grihagolika* (Common Lizards, Lacertilia), *Matsya* (Pisces) *Kūrma* (Tortoises, Chelonia, Reptilia), *Śuśumāra* (Dolphin or porpoise, Cetacea), and birds proper with feather wings—*Lomapakṣa Pakṣis*.⁷⁶

Śiśumāras are erroneously placed under this class, being really viviparous like other cetacea which belongs to the Mammals. (2) *Jarāyuja*,⁷⁷ mammals born with placenta, including all mammals other than the *Potaja*:

1. Man, cow, buffalo, goat, sheep, horse, ass, camel, deer, yak, hog, *Bos Gavaeus*, (Gāvaya—Ungulata), lion, tiger, bear, panther, dog, jackal, cat, etc.⁷⁸

(3) *Potaja*,⁷⁹ a class of placental mammals comprising the Deciduata with the exception of Man, the Apes, and the Carnivora, e.g. *Śallaka* (porcupine, Rodentia), *Hasti* (Elephant, Proboscidea), *Śveti* and *Lāpaka* (Hedgehogs and other creatures that lap up, Insectivora), *Śaśa* and *Śayika* (hare, rabbit, and squirrel, Rodentia), *Nakula* (Ichneumon, which though carnivorous is supposed to come under the Deciduata), *Mūṣika* (mice, Rodentia), and the *Carmapakṣa Pakṣi*, so-called birds with leathern wings (bats, Chiroptera), e. g. *Valguli* (flying—fox), *Pakṣivirāla* (flying cat, Micro—chiroptera) and *Jalūkā* (blood-sucking bats or Vampires).⁸⁰

75. *Tattvārthādhigama Sūtra* II. 34.

76. *Ibid.*

77. According to the Jainas, *Jarāyuja*, (viviparous—lit., placentalia) means only those viviparous animals which come out at birth with the placenta (a Deciduata), while *Potaja* is a class of placental mammals comprising the Deciduata with the exception of Man, the Apes, and the Carnivora. *Potaja* means literally viviparous animals born without placenta. The *Potaja* class comprises, the following Deciduata. Proboscidea, Rodentia, Insectivora and Chiroptera.

78. *Tattvārthādhigama Sūtra* II. 34.

79. *Tattvārthādhigama Sūtra*, II. 24,

80. *Jarāyujānām manusya—go—mahīśājāvikaśca kharoṣṭramīga—camara—varāha—gavayasiṁha—vyāghraṅka—dvīpiśva—śīgalamārjārādinām / Andājānām sarpagodha Kṛkalāsa gṛhagolīka—matsya—kūrma—nakra—śeśumādinām / pakṣīṇām ca lomapakṣāṇām / haṁsacāśa—śuka—gṛdhra—śyena—pārāvata—Kāka—mayūramadgubaka—balākādinām/Potajanām śaśa—hasti—śvāvillāpaka—śaśa—śayikā—nakula—mūṣikādinām / Cārmapakṣīṇām ca pakṣāṇām Jalukā valaguli bhāraṇḍa—pakṣivirā—lādinām garbhe janma /” *Tattvārthādhigama Sūtra*, Ch. II, Sūtra 34.*

Mammals :

All the Jarāyuja and Potaja⁸¹ animals come under the species of the Mammals. "The distinguishing features of Mammals are the presence of hair, mammary glands sweat glands, and the differentiation of the teeth into incisors, canines and motors".⁸² There are many sub-classes of the Mammals.

The Jarāyuja and Potaja animals of Jaina Biology form the sub-class of the Mammals—the Eutheria of Biology which includes all the other mammals, all characterized by the formation of placenta for the nourishment of the developing embryo while within the uterus (Garbha or Jarāyu) of the mother. Some of the principal orders of Jarāyujas and Potajas (i. e. placental mammals) are the following :

- (1) Insectivora – hedge-hogs (and other creatures, that lap up, e.g. Śvavit and Lāpaka, they are Potajas).
- (2) Chiroptera – bats (Valguli⁸³ – flying fox – Potaja, Pakṣivirāla – flying Cat, Micro – Chiroptera – Potaja, Jalūkā (blood sucking bats or Vampires – Potaja).
- (3) Carnivora – (Jarāyuja, lion, tiger, bears, panther, Biḍāla = Cat, Śunaga = dog, foxes (Śṛgāla), etc.
- (4) Rodentia (Śallaka = porcupine, muṣika = mice, Śaṣa and Śayika = hare, rabbit and squirrel). These mammals have sharp chisel-like incisor teeth.
- (5) Primates – men, apes and monkeys.
- (6) Artiodactyle – cattle, cow and buffalo, goat, sheep, hog, deer etc. Herbivorous hooved animals with an even number of digits per foot.
- (7) Perissodactyle – horse, ass, camel, rhinoceroses (Assa, Gaddabha, Uṭṭha, Gaṇḍāra).
- (8) Proboscidea (Potaja, hasti, elephant).
- (9) Cetacea – Whales, dolphins and porpoises (Timi and Suśumāra)
- (10) Ichneumon (Nakula, mongoose, Deciduata – Mammals).

81. Tattvārthādhigama Sūtra II. 34.

82. Biology. p. 244.

83. A kind of Carmapakṣin, as already pointed out as Valguli.

It appears from the study of the hosts of animals as given in the Jaina Āgamas that the various members of the animal kingdom cannot be placed on a single scale ranging from lowest to highest, for their evolutionary development has occurred in the manner of a branching tree, rather than in a single continuous series. It cannot be said, for example, that the *starfish* is "higher" or "lower" than the Śamvuka (*Helix*) or Śankha (*Concifera*) or Oyster, the two forms are simply representatives of the two main trunks of the evolutionary tree, between the two groups are deep-lying differences of structure and development.

MAN :

Men are of two kinds, viz. Saṁmūrcchima (asexually reproduced or reproduced by generation *acquivoca*) and Garbhavyutkrāntika (men born from the womb i.e. sexually reproduced).⁸⁴

As pointed out, men belong to the sub-class of the Mammals. Saṁmūrcchima manusyas are born in all kinds of dirty places, such as, places of urination, etc.⁸⁵ It is not possible to recognize them in the light of modern Biology at the present state of our knowledge in the field of taxomony.

Conclusion :

The classification of animals as made in Jain Biology may be summed up by making a comparative study of it with that of animals as found in other Indian Biological Sciences in some respects. For example, Saṁmūrcchima Jivas⁸⁶ (from two-sensed to four-sensed animals asexually reproduce) of Jaina Biology may be identified with Ayonija Kṣudra Jantus⁸⁷ (asexually generated small animals), e. g. svedajas (animals born of moisture and heat) and Udvijja (born of vegetable organisms or metamorphic e. g. the coccinella).⁸⁸ Yonija Kṣudra Jantus⁸⁹ (sexually generated small animals), e. g.

84. Uttarādhyayana Sūtra, 36.171. ; Pañnavāṇa 1.92 Tattvārthādhigama Sūtra II. 34.

85. Pañnavāṇa, 1.56

86. Uttarādhyayana Sūtra, 36.171 ; Pañnavāṇa, Sutta 1.56.57.58,

87. Praśastapadādabhāṣya (śāriṇam dvividhām-Yonijamayonijām ca etc.), Kṣudrajantūnām etc. Pṛthivinirupāṇām/”

Patañjali's Mahābhāṣya, 2 4.1. (Athavā Nakulaparyanta Kṣudrajantavaḥ)

88. Caraka, Śārirosthāna, Chap. III. 16 “ Bhūtānām Caturvidhā Yonirbhavati jarāvāṇḍasvedodbhidah ” Ekaikā yonih aparisamkhyeyabhid bhavanti Bhūtānām ākṛtivīśeṣā parisainkhyeyatvāt of Ibid)

89. Praśastapādabhāṣya, Pṛthivirūpāṇām /”

the Aṇḍajas (oviparous) and Jarāyujas⁹⁰ (viviparous) of Brāhmaṇical Biology are identical with the Tirikkhayoniya Jīvas (Aṇḍajas and Jarāyujas⁹¹ – lower animals born of eggs and lower animals born from the womb as a result of sexual union) of Jaina Biology. In both the Biological sciences the two-sensed animals or the Kṣudrajantus (small animals), like (1) Kṝmis⁹² (worms or Vermes), (a) Apādikas,⁹³ without lateral appendages (Scoleids), (b) Nūpurakas⁹⁴ (Annelids), and (c) Gaṇḍūpadas⁹⁵ (Arthropoda), (II) the Jalaukās⁹⁶ (Leeches)⁹⁷ and (III) Kośasthas, (shelled animals), i. e. some forms of Mollusca, e. g. the Śankhas (Conchifera), the Śukṭikas⁹⁸ (Pearl mussels), the Śambukas (spiral shelled Helix), Vodika, etc.⁹⁹ come under the category of the Invertebrata. (IV) The three-sensed animals of Jaina Biology and the Insects of Brāhmaṇical Biology, typified by the ants comprising (a) Pipilika,¹⁰⁰ Rohinikā (ants, Hymenoptera), (b) Upacikā, Kunthu, Tuburaka (bugs and flies, Hemiptera, (c) Trapusavija – Kārpāsāsthikā (Cucumber-and Cotton-weevils and Lice, Aptera), Ametabola), (d) Śatapadi, Utpatāka (Centipedes, Spring-tails, Aptera), (e) Trṇapatra (Plant- or grass- lice, Aptera) and (f) Kāṣṭhahāraka

90. Ibid.

91. Bhagavatī Sūtra, 7.5.282; Jivābhigama Sūtra 3.1.96; Pāṇṇavāṇa 1.61-91. Tattvārthādhigama Sūtra II. 34.

92. Uttarādhyayana Sūtra 36.128; Suśruta (Kṝmis), Dalvana.

93. Of Suśruta's careful description, Sutrasthāna, Ch. XIII; Tattvārthādhigama Sūtra, II. 24 (apādika)

94. Tattvārthādhigama Sūtra II. 24.

95. Tattvārthādhigama Sūtra II. 24.

96. Tattvārthādhigama Sūtra II. 24; Suśruta, Sutrasthāna, Ch. XIII (Athāto jalaukā .. etc.

97. Tattvārthādhigama Sūtra II. 24; Ibid.

98. Caraka and Suśruta, Ch. XXVII, Sutrasthāna, Dalvana “Śuktiśāṅkha, etc. (Caraka Sutrasthāna XXVII) no. “Voḍikajala śuktisambūka bhedā bahubheda grhyant” Delvania

99. Ibid. Tattvārthādhigama Sūtra II; 24.

100. “Suśruta – Nāgarjuna names six varieties of Pipilikā (ants), six varieties of Makṣikā (flies), five varieties of Maṅkas (mosquitos) including one marine and one mountain kind, eight varieties of śatapadiś (centipedes), thirty varieties of scorpions, and sixteen of spiders (Lutās). Of the kiṭas, the glow-worm and the Tailakiṭa (lit-oil-worm) are said to be luminous (phosphorescent) ca. Rājanighanta – Khadyota tailakiṭau”, vide the Positive Sciences of the Ancient Hindūs, p. 194.

(Termites, white ants – Neuroptera, Hemimetabola)¹⁰¹ form the Higher Invertebrata.

Besides the four-sensed animals of Jaina Biology¹⁰² and the Insects of Brahmanical Biology¹⁰³, typified by Hexopoda, (Saṭapada) comprising (a) Bhramara, Varaṭa, Sāranga, (bees, wasps, and hornets), (b) Makṣikā, Puttikā, Dāmśā, and Maśakas (flies, gnats, gadflies and mosquitos), (c) Vṛścikas and Nandyāvartas (Scorpions and spiders – Arachnida, Arthropoda), (d) Kiṭa (butter-flies and moths) and Pataṅgas (grass-hoppers and locusts) also belong to the class of the Higher Invertebrata. They are all oviparous (aṇḍajas)¹⁰⁵ according to both the sciences.

The Tiryak-Yoni animals having five sense-organs of Jaina Biology¹⁰⁶ and Brāhmanical Biology,¹⁰⁷ i. e. lower animals with five sense-organs, sexually generated, correspond to the Phylum Chorodata-the Vertebrata possessing bones and blood. They are classified on the basis of their mode of reproduction.

They are as follows :

(1) Aṇḍajas,¹⁰⁸ (oviparous animals) comprise (a) Matsya (fishes), Timi (whale), Makara (Shark ?), Kūrmas (tortoises), Kumbhīras or Nakras (Grāhās) (crocodiles), Śuśumāras (dolphins), (b) Uragas (apodal reptiles including sarpas-snakes, Ophidia) which move on breast. (c) Bhujagas (oviparous animals) with lateral pedal appendages which walk on arms, i. e. both Reptiles and Batrachians including Godhā (Varantas lizards), Gṛhagolika (common lizards) and Krikalāsa

101. Paññavaṇā, 1.57. ; Tattvārthādhigama Sūtra II. 24

102. Paññavaṇā Sutta 1.58 ; Tattvārthādhigama Sutta II. 24.

103. See Caraka – Suśruta, Dalvana. Caraka Sūtrani and Chapter XXVII (Mākṣikām bhrāmaraṁ etc,) 243 Suśrutas, Kalpasthāna Ch. VIII

104. Paññavaṇā Sutta 1.58. ; Tattvārthādhigama Sūtra II. 24.

105. Tattvārthādhigama Sūtra II. 34. Praśastapādabhāṣya.

106. Paññavaṇā Sutta 1.61-92 ff. Tattvārthādhigama Sūtra II. 24, 34.

107. i. e. Kṣudrajanus of Brāhmanical Biology –; sexually generated lower animals possessing bones and blood. Corresponding to the vertebrata are identical with Tiryakyoni animals, sexually generated.

108. Tattvārthādhigama Sūtra II. 34 ; Praśastapādabhāṣya, etc. Pṛthivinirupanām “Pakṣisarisṭpāṇāmaṇḍajām”.

(chameleons).¹⁰⁹

(2) Kūrmas and Nakras (tortoises and Crocodiles - Chelonia and Emydesauria, Reptitia).

(3) Śiśumāras¹¹⁰, the Dolphinidae (Odontoceta cetacea). Śiśumāra, is not ovipārous as mentioned in Jaina Biology. It does not name Karkata (Crabs - crustacea), but it is mentioned in Śuśruta. The sub-class of Bhujagas of Jaina Biology, being a natural sub-division of the Vertebrates, does not comprise crustacea which are rightly placed under the category of the Invertebrates and (d) Lomapakṣa Pakṣins¹¹¹ (winged animals with feathery wings, i. e. birds proper), while Carmapakṣa Pakṣin¹¹² (winged animals with leather wings), though they have been placed under the category of birds in both Jaina and Brāhmanical Biologies¹¹³ on the homologous basis, belong to the Placentalia of the Deciduata class (Potaja). II. Jarāyujas and Potajas¹¹⁴ (Viviparous, lit. placentalia) as classified in both the Biological sciences are placed on the same basis of mode of reproduction. They are as follows: (a) Carmapakṣa, pakṣins (leather-winged animals, which are Potaja-Deciduata), viz. Valguli (flying-fox), Pakṣi-virāla (flying cat, Micro-chiroptera), Bhāraṇḍa pakṣin-a species of Micro-chiroptera), the horse-shoe bat?) and Jalukā (blood-sucking bat or Vampire bat?)¹¹⁵

(b) Vileśaya Jarāyujas¹¹⁶ (mammals that live in holes of burrows, including various species of Rodents and Insectivora, such as Mūṣika, (mice), etc.

109. Tattvārthādhigama Sūtrā II. 34.

Śuśruta mentions "four varieties of the Kanava(bhaka), a species of (Chemeleon-like lizards, (cf. Lādyāyana, quoted by Dalvana, Kalpasthāna, Chapter VIII, six varieties of Galagolika (a species of lizards), and five varieties of Gaudheraka Varanus-like lizards, but smaller in size, vide the Positive Sciences of the Ancient Hindus, p.196. "Kāṇḍīliyakāḥ Kanabhako etc. Kalpasthāna, VIII", Galagolyastu, sarṣapiketyevam. Ibid, // "Gaudherakāḥ sthāikā (Ibid. 21)

110. Tattvārthādhigama Sūtra II. 34.

111. Paññavaṇā Sūtra, 1,86, ; Tattvārthādhigama Sūtra II. 34.

112. Ibid.

113. Tattvārthādhigama Sūtra II. 34. ; Prasastapādabhāṣya (Pakṣisarīspāṇamāṇḍajam) Pṛthivinirūpaṇam.

114. Tattvārthādhigama Sūtra II. 34. ; Carmapakṣāṇām ca pakṣāṇām Jalukā-Valguli - Bhāraṇḍa Pakṣivirālādinām garbhe janmāḥ /"

115. Ibid.

116. Vileśaya class of animals is included into the group of Jāngala animals. See Suśruta, Sūtrasthāna, Chap. XXVII.

(c) *Parṇamṛgas*¹¹⁷ (arboreal mammals, comprising some Rodents (Śāśa, Śāyikā, hare, rabbit,¹¹⁸ squirrels, etc.), a wild - cat - the sloths and the apes.¹¹⁹

(d) Non-carnivorous quadrupeds (*Catuṣpadas*), *Akravyādāḥ*, such as, *Jāṅgalas*¹²⁰ - mṛga, (deer), etc., (2) *Kulecaras*¹²¹ (mammals grazing on the banks of rivers and frequently marshy places, e.g. *Hasti* (elephants), *Gaṇḍāra* (rhinoceros), *Gāvaya* (*Bos gavaeus*), *Mahiṣa* (buffalo), *Varāha* (hog), some species of deer also, (3) *Grāmyas*¹²² (domesticated quadrupeds), some with undivided hoof (*ekaśapha* i.e. *egakhurā*),¹²³ e.g. *Aśva* (horse), *Aśvatara* (mule); *Gardabha* (ass), some with cloven hoof (*dvikhurā*), e.g. *Uṣṭra* (camel), *Goṇa* (cow), *Aja* (goat), *Āvika* (sheep),¹²⁴ etc.

(e) Carnivorous quadrupeds, *Guhāśaya*¹²⁵ (living in natural caves or hollows, Carnivorous - *Kravyāda* or *Sanapphadā*, comprising *Siṁha* (lion), *Vyāghra* (tiger), *Rkṣa* (bear), *Dvipina* a kind of tiger, leopard or *Panther*), *Śvā* (dog), *Sṛgāla* (Jackal), *Mārjāra* (cat),¹²⁶ etc.

The Carnivora are termed *Vyālas*,¹²⁷ or *Kravyādas*¹²⁸ and Herbivora as *paśus*¹²⁹ in the Brāhmaṇical works in a wider sense.

117. *Parṇamṛgas*, apes, etc. are also enlisted in the class of *Jāṅgalas*, *Ibid.*

118. *Tattvārthādhigama Sūtra* II. 34.

119. *Bhagavatī Sūtra* 12.8.460.

120. *Kalyāṇakāraka* mentions *Jāṅgala* and *Anūpa* animals, *Kalyāṇakāraka*. V. 19, p. 21; *Suśruta*, *Sūtrasthāna*, Chap. XXVII. It also gives a list of dietary animals. They are divided into two classes, viz.

(1) *Anūpas* (animals that live in marshy land or water-logged land (or water) (2) *Jāṅgala* animals that live in dry (hilly) jungle land. The *Anūpas* are subdivided into eight classes and the *Jāṅgalas* into five on the basis of real and natural distinctions of food and natural habitat, in all they are sub-divided into thirteen classes; "Trayodasabhedā ṣaṣṭu eva antarbhūtāḥ / Saṁkhyeyāṁ nirddeśādeva ṣaṭsaṁkhyāyāṁ labhāyāṁ tena ṣaḍvargā iti niyamārthaṁ .. *Dalvana*, *Sūtrasthāna*, Chap. XXVII.

121. *Kulecaras* are included into the class of *Anūpa*.

122. *Grāmyas* are placed in the class of *Jāṅgalas*.

123. "Grāmyāśabdena ca ekaśaphaśabdena ca grāmyāśapalī kṣurāḥ - *Dalvana*".

124. *Tattvārthādhigama Sūtra* II, 34.

125. *Guhāśaya* is included into the class of *Jāṅgala*.

126. *Tattvārthādhigama Sūtra* II. 34.

127. *Suśruta*.

128. *Ibid.*

129. *Ibid.*

Aristotle, the greatest of Ancient biologists, mentions "some five hundred different animals, a large number relatively to the knowledge of the time"¹³⁰. He arranged animals in a Scala Naturae according to the principles of mode of generation (asexual - sexual), homology, habitat, spontaneous generation, similarity of structure, etc. But "Keswani"¹³¹ contends that Aristotle's (384-382 B. C.) Scala Naturae which is considered as the earliest scientific classification of animal kingdom actually never occurs in any of his writings and has been somewhat forcibly extracted out of Aristotle's text."¹³²

Like this Greek philosopher the Jainācāryas recognize in principle three grades of likeness or similarity in animal classification, viz. (1) the complete identity of type, which exists within a single species, (2) the likeness between species of the same great genus (such species have the same bodily parts, differing only in degree in number, size, etc.), (3) the likeness by analogy between 'greatest genera' themselves, on the basis of sense-organs, for the Jainācāryas, grasped firmly, the homology between arm, foreleg, wing, fin, between bone and fish spine, between feather and scale.

They never applied any cut-and dried classification. They were well aware of the difficulties of the existence of isolated species which fall under no recognized greatest genera and of species intermediate between two such genera. But their classification is clear enough in its main lines. It was a great advance on anything that preceded it in the Vedic period and no further advance on it was made in the field of Ancient Indian Biology. Their widest divisions are Dvindriya (two-sensed), Trindriya (three-sensed), Caturendriya (four-sensed) and Pañcendriya (five-sensed) animals answering to the modern Invertebrates (two-sensed animals, three-sensed animals and four-sensed animals), and Vertebrates (five-sensed animals, on the basis of the number of sense-organs possessed by each of them and also on that of habitat-Jalacara (aquatic), Sthalacara (terrestrial) and Nabhabacara (aerial). Of the Pañcendriyas (five-sensed animals) the main genera are viviparous quadrupeds (Catuṣpada) (Cetacea) and oviparous

130. Aristotle by W. D. Ross, Chapter IV, pp. 112 ff.

131. Keswani N. H., The Concepts of generation, reproduction, evolution, and human development as found in the writing of Indian (Hīndus) scholars during the early period (up to A.D. 200) of Indian History, Bulletin of National Institute of Sciences of India, No. 21, p. 208, 1961.

132. Singer. C. A. A Short History of Anatomy from the Greeks to Harvey Daver. Nrw York, p. 209, 1957.

birds (Pakṣin) and apoda—oviparous reptiles (parisarpas) and ampibia (frog = maṇḍuka) and oviparous fishes (matsya).

Besides these there are the isolated species—man and certain intermediate species. Dvīndriya, Trīndriya and Caturendriya animals (lower and higher invertebrates) are divided according to the consistency of their inner and outer parts and sense—organs.

Each of these genera has many differentiae and they accordingly be grouped in many ways, but the most illuminating of those as suggested by the Jainācāryas is that which depends on the mode of generation—Saṁmūrcchima and Garbhavyutkrāntika, Aṇḍaja, (oviparous) Jarāyuja and Potaja (viviparous). The highest types of animals are the Jarāujas and Potajas (vivipara), i. e. those which have vital force to reproduce sexually offspring qualitatively like the parents. The next type is that in which an egg is produced (aṇḍaja) out of which an issue gets generated.

Lower still come the types of animals which produce asexually (Saṁmūrcchima) a slimy fluid from whish they develop ; while in others the young simply bud off from the parents. And finally in all lower types and occasionally even as high as the fishes there occurs spontaneous generation (Saṁmūrcchima) from lifeless matter, such as sveda (dirt or sweat).

FOURTH CHAPTER
THE ORGANISATION OF THE HUMAN BODY
(First Section)

Blood and Circulatory System.

The Organisation of the body (śarīra)¹ of developed animals, particularly, of men, includes the transport system of the body, i. e., blood and vessels (śirās, etc.)² that supply all cells with nutrients (rasa)³ and remove the waste products (mutta, etc)⁴ of metabolism and the circulatory system⁵, the respiratory system, the digestive system together with metabolism and nutrition, the excretory system, the integumentary and skeletal systems, which protect and support the body, the muscular system which moves the various parts of the body-one on another, the nervous system, the sense-organs by which animals obtain and process information regarding the external environment, and the endocrine system.

Enumerating the contents of the human body the Jainācāryas state that usually this body is a collection of blood (śoṇita or rūdhira)⁶ and blood vessels—seven śirās (arteries or veins), twenty four dhamanis (vessels, veins or arteries carrying nutrient) and eight śrotas (currents),⁷ lungs including eparterial bronchioles of trachea (phoppasaphephasa),⁸ gastro-intestinal tract starting from mouth cavity, oesophagus upto the colon of the large intestine (mukha . . . āmoruhakkāśaya—

1. Tandula Veyāliya 16, pp. 34-35.

2. Tandula Veyāliya 16, p. 35. (Ruhira, śirās, dhamanis) and śrotas (Kalyāṇakāraka 3.4).

3. Imāmmi sarirae saṇṭhi sirasayaṇām nābhippabhavāṇām uḍḍhagāminīṇām śiramuvagayāṇām jāo? rasaharaṇiotti vuccanti janāṇsi. etc.” Ibid, p. 35.

4. “Imassa jaṇtussa saṇṭhisirāsayaṇām nābhippabhvāṇām ahogamīṇām gudappaviṭṭhāṇām jaṇāṇsi, niruvaghāṇām muttāpurisavāyūkamām pavattai,” Ibid., 16, p. 35.

5. Tandula Veyāliya 16, p. 35.

6. Tandula Veyāliya 3, p. 7; 6, p. 10; 16, p. 35; Kalyāṇakāraka, 3, 7, p. 31 (rakta) Śoṇiya (Āṅgavijjā, p. 171)

7. Tandula Veyāliya, 16. p. 35 (Śirā ; dhamani (Āṅgavijjā 1970, p. 66) ; Kalyāṇakāraka 3.2 ; 3.3, p. 30 ; 3.4 ; p. 31. ; Kalyāṇakāraka mentions eight śrotas (currents). 3.4, p. 21.

8. Tandula Veyāliya, 17, p. 38.

sthūlāntra paniktiḥ),⁹ the excretary organs-kidney¹⁰ (taṇūyamīta ?) and large intestine (thūlamīta),¹¹ nine orifices (navasoyā),¹² skin (camma),¹³ a skeleton¹⁴ of three hundred pieces of bones,¹⁵ articulated by one hundred sixty joints,¹⁶ bound together by nine hundred sinews of ligaments,¹⁷ plastered over with five hundred pieces of muscles¹⁸, enclosed with outer cuticle,¹⁹ with orifices,²⁰ here and there, constantly dribbling and trickling like cracked or perforated pot,²¹ infested by helminths²² and always oozing from the nine orifices²³ (wax from the ears, rheum from the eyes, snot from the nostrils, undigested food, bile, phlegm and blood from the mouth and feaces from the anus and urine from the urethra through the penis²⁴ and sweating through ninety nine lakh of hair follicles,²⁵ five sense-organs²⁶ (ear, eye, etc.) and 170

9. Tandula Veyāliya, (Thulaṇīte), 16. p. 35. ; Kalyāṇakāraka, 3.4, p. 31. (amorūpakkāśaya . sthūtantra)
10. Taṇūyamīta ? Its function indicates that it is kidney (Je se taṇūyamīte teṇamī pasavaṇe pariṇamai", Tandula Veyāliya, 16, 35. But literally taṇūyamī means small intestine where all eaten food is churned and digested.
11. Je se thulaṇīte teṇa uccare pariṇamai. Tandula Veyāliya 16, p. 35
12. Navasoc purise ikkārāsasoyā itthiya, Ibid. See also Kalyāṇakāraka, 3.5, 10, 11, 12.
13. Tandula Veyāliya, p. 41. "Aṭṭhiyakaḍhiṇe siraṇhārubamīḍhane māṁsacammalevāmī /"
14. Ibid.
15. Ibid., 16, p. 35. "Tinni aṭṭhidāmasayāmī," "Kalyāṇakāraka 3.2, p. 38.
16. "Saṭṭhi saṁdhisayāmī", Tandulaveyāliya 16, p. 35. Kalyāṇakāraka mentions three hundred joints.
17. "Nava ṣhārūsayaṁmī", Tandula Veyāliya 16, p. 35. ; Kalyāṇakāraka, 3.2, p. 36.
18. Pañcā pesīsayāmī purisassa tīsūnāmī itthiyāe vīsūnāmī paṇḍagassa /" Ibid. The woman has 470 pieces of muscles and the neuter has 480 pieces of muscles.
19. Aṭṭhiyakaḍhiṇe siraṇhārubamīḍhane māṁsacammalevāmī /" Tandula Veyāliya. p. 41.
20. Navaśrotas – two ears, two eyes, two nostrils, one mouth, one anus or rectum (payu) and one urethra (through penis) (upastha) and skin also is the other orifice, Tandula Veyāliya, 16, p. 35. p. 41.
21. Evaṁ sīavadvīṇaghaṭopamān deho navadvāragalaṁ malāḍhyāḥ /, Svedāmī vamatyutkāṭaromakūpa ryūkāsalikṣṭapadāśca tajjāḥ / Kalyāṇakāraka, 3.12, p. 32.
22. Ibid.
23. Tandula Veyāliya, 16, p. 35; p. 38. Kalyāṇakāraka 3.5, 10, 11, 12.
24. Ibid.
25. "Nava nauīm ca romakūvasayasaḥassāmī" Tandula Veyāliya, 16, p. 35.
26. Pññavaṇā Sutta, Indriyapada, 15, "Soimdiyattāe cakkhuriṁdiyattāe ghaṇm̄diyattāe jibbhiṁdiyattāe phāimdiyattāe /", Tandula Veyāliya 3, p. 7.

sensitive parts (*mṛma*) of the body,²⁷ some endocrine glands,²⁸ etc.

In the description of the body, like *Buddhaghoṣa*²⁹ the Jainācāryas have intentionally sketched it to create a repulsion in the minds of their followers towards it.³⁰ But the definitions or rather anatomical description of the body given by *Caraka*³¹ and *Suśruta*³² in this context are quite different from the Jaina and Buddhist views on it as their objective was to deal with medical science.

So the Jainācāryas suggest to their monk followers to review the different aspects of the human body.³³ They do not define like *Caraka*³⁴ and *Buddhaghoṣa*³⁵ that it is constructed out of five or four primary elements of matter. Nevertheless, they admit that the body is constituted of matter (*Pudgala*)³⁶

The main aspects of the body as described by Jaina Biology, starting from blood (*soṇita*³⁷ or *rudhira*³⁸) down to some endocrine glands are as follows : blood³⁹, hard or congealed fat (*meda*),⁴⁰ semi-liquid fat (*Vasā*),⁴¹ synovia (*raiya*),⁴² spittle (*khela*),⁴³ snot (*śimgānaka*),⁴⁴

27. "Sattuttaram mammasayam" *Tandula Ve yāliya*. 16, p. 35.

28. Testes, ovaries, seminal glands etc.

29. *Visuddhimagga* VI, 89, VI. 46. (*sariram hi asuci*)

30. *Taadulaveyāliya*, p. 38 (*māṇussayam sariram pūiyam*)

31. *Carakasāṁhitā* IV. 6-4. *Tatra śariram nāmā Cetanādhishṭhānabhūtam* etc.

32. *Suśruta Saṁhitā* 1-1 5.3 " *Tacca-Śaḍaṅgamā ḫakhāscatasro madhyamā Pañcamamā saṁthām śiram iti /*" etc.

33. *Tandula Veyāliya* 16, p. 3ⁱ, 17, p. 38, etc.

34. " *Tatra sariram nāmacetanādhishṭhānabhūtam pañcamahābhūtavikāramudayāt - makām samayogavāhi /*" *Caraka* IV. 6.4.

N. B. *Buddhaghoṣa* does not include *ākāśa* element and consciousness (*Cetana*) in the group of *mahābhūta*.

35. " *Imam eva kāyam ti imañ catumahābhūtikam* ", *Visuddhimagga* VII, 45.

36. " *Sarīravāṅgamanaḥprāṇapānāḥ pudgalānām /*" *Tattvārthādhigama Sūtra* V. 9

37. *Tandula Veyāliya* 3, p. 7.

38. *Ibid.* 16, p. 35.

39. *Tandula Veyāliya*, 3, p. 7 ; 16. p. 35, etc.

40. *Meda*, *Tandula Veyāliya*, p. 40.

41. *Vasā*, *Ibid*, p, 40

42. *Ibid.*, p. 40.

43. *Rasiya*, *Ibid.*

44, *Ibid.*

bile (pitta),⁴⁵ phlegm (śimbha),⁴⁶ liver (yakṛt),⁴⁷ spleen (piliha),⁴⁸ pus (Puvva),⁴⁹ heart (hiyaya), blood vessels (śirās, dhamanis)⁵⁰ and śrotas),⁵¹ lymph vessels (śleśmāśirā or Kaphasthāna)⁵², lymph (simbha or kapha)⁵³, tissue fluid (rasa),⁵⁴ oxygen and carbon dioxide (ānapāṇa or ucchvāsanihsvāsa),⁵⁵ lungs including eparterial bronchioles of trachea (phopphasaphephasa),⁵⁶ mouth cavity (mukha),⁵⁷ stomach (udara or amoru)⁵⁸ duo denum (pakkasa),⁵⁹ small intestine (taṇuyaṁta)⁶⁰, large intestine (sthūlāntra),⁶¹ tongue (jihvā or jihā)⁶² teeth (daṁtā),⁶³ anus or rectum (pāyū),⁶⁴ urethra or urinal duct (upastha),⁶⁵ kidneys,⁶⁶ nine orifices,⁶⁷ urine (mutta),⁶⁸ faeces (puriṣa),⁶⁹ skin (camma),⁷⁰

45. Ibid, p. 13, p. 41.

46. Kalyāṇakāraka 3.4, p. 41. (Śimbha)

47. Tandula Veyāliya (Yakṛt) 17, p. 38.

48. Ibid., p. 40.

49. Tandula Veyāliya 17, p. 38.

50. (Hiyaya), Tandula Veyāliya 17, p. 50.

51. Tandula Veyāliya 16. p. 35; Kalyāṇakāraka, 3.4, p. 31. (8 Śrotas – Currents).

52. See Khaphasthāna, Kalyāṇakāraka. 3.49, p. 40.

53. Ibid. 3, 7, p. 31.

54. Tandula Veyāliya, 16, p. 35.

55. Ibid 4, p. 8 ; Bhagavatī Sūtra, 1.7-61-2, Viśesāvaśyakabhāṣyagāthā 2714 ; Navatattvaprakaraṇam V. 6, p. 12

56. Tandula Veyāliya, 17, p. 38.

57. Tandula Veyāliya. 38.

58. Tandula Veyāliya 17, p. 38 (Udara)

59. Kalyāṇakāraka ; 3.4.

60. Tandula Veyāliya, 16, p. 35. ;

61. Tandula Veyāliya, 16, p. 35. ; Kalyāṇakāraka 3.4, p. 31.

62. Tandula Veyāliya, 3, p. 7; 16, p. 35 (Jihā)

63. Ibid., 16, p. 35 (battisāṁ daṁta)

64. Tandula Veyāliya, p. 38 (One of the śrotas). Tanuyaṁta transforms urine.

65. Ibid.

66. Taṇuyaṁta ? (Tandula Veyāliya 16, p. 35). There is no separate mention of kidney (Vakka)

67. Tandula Veyāliya 16, p. 35. (navasoe).

68. Ibid.

69. Ibid.

70. Ibid., p. 41.

outgrowths of skin – hair (*keśa*),⁷¹ body – hairs (*romas*),⁷² and nails (*ankha*),⁷³ sweat (*seya*),⁷⁴ skeleton (*atṭhiya*),⁷⁵ bones (*atṭhi*),⁷⁶ various parts of the skeleton,⁷⁷ the number of bones,⁷⁸ bone marrow (*atṭhimimīja*),⁷⁹ brain matter (*matthulūṅga*)⁸⁰ joints (*saṁdhī*)⁸¹ firmness of joints (*saṁdhāyana*),^{81a} pieces of muscle (*māṁsapeśi*),⁸² nerves (*ṇhāru*),⁸³ ligaments (*Kamīdarā?*),⁸⁴ tendous (*māṁsarajju*),⁸⁵ sense – organs (*indriyas*)⁸⁶ and a few endocrine glands – seminal ducts and testes,⁸⁷ ovaries,⁸⁸ (*Kucchi?* or *Garbhāsaya?*) fallopian tubes (*sirādugāṁ*),⁸⁹ uterus (*yoni*),⁹⁰ etc.

71. Ibid., 3, p. 7.

72. Ibid.

73. Ibid.

74. Ibid., p. 40 (*seya*)

75. Ibid., p. 41.

76. Ibid., 6, p. 10; 16, p. 35.

77. Ibid., 16, p. 35, 17, p. 38.

78. “*Tīṇṇī atṭhidāmasayāīm*”, *Tandula Veyāliya*, 16, ; p. 35 ; *Kalyāṇakāraka*, 3.2.

79. *Tandula Veyāliya*, 6, p. 10. ; *Bhagavatī Sūtra* 1. 7. 61–2.

80. *Tandula Veyāliya* 6, p. 11, ; *Bhagavatī Sūtra* 1. 7., 61–2.

81. *Tandula Veyāliya* 16, p. 35. “*Saṭṭhi saṁdhīsayam*

81a *Lokaprakāśa* 3. 399, p. 132.

82. *Tandula Veyāliya* 2, p. 6. 16, p. 35. ; *Kalyāṇakāraka*, 3. 2.

83. *Tandula Veyāliya* 16, p. 35. *Kalyāṇakāraka* 3. 2, p. 30.

84. *Kāṇḍarā* mens thick (or big) nerves. They may be ligaments also. See *Kalyāṇakāraka* 3.4, for *Kamīdarā*.

85. *Kalyāṇakāraka* 3. 4, p. 31.

86. *Bhagavatī* 2. 4. 99 ; *Pañṇavaṇā Sutta* 15. *Indriyapada* ; *Tandula Veyāliya* 3, p. 7 : *Tattvārtha Sūtra* II. 15 “*Pañcendriyāṇi*”

87. Seminal ducts, testes, “*Dasasirāo Sukkadhāriṇio*”, *Tandula Veyāliya*, 16, p. 35. Even *Taṇuyaṁta* (Small intestine) and *Taūlaṁta* (large intestine) are regarded as endocrine glands.

88. *Garbhāsaya?* *Sthānīya* 6 ; *kuccāi?* (*Tandula Veyāliya*, 16 p. 35) Vide *Tandula Veyāliya*, p. 4.

89. “*Nābhīhīṭhā sirādugāṁ*”, *Tandula Veyāliya*, p. 3.

90. “*Tassa ya hiṭhā joni ahomūhā samīhiyā kosā I.*” Ibid.

Blood (Śoṇita⁹¹ or Rudhira⁹² or Rakta)⁹³

The metabolic process of all cells of the body require a constant supply of food (āhāra)⁹⁴ and oxygen (ussāsa)⁹⁵ and a constant removal of waste products (mutta, purisa, etc.).⁹⁶ This is accomplished simply by diffusion⁹⁷ in animals in a watery environment,⁹⁸ but man and all the larger animals have developed some system of internal transport, a circulatory system (śirās, etc.).⁹⁹

The circulatory system of man and all larger animals includes the heart (hiyaya)¹⁰⁰ and blood vessels (śirās, dhamanis, śrotas),¹⁰¹ the lymph vessels (Sirāo, simbhadrhinī¹⁰² or Kaphasthaāna)¹⁰³ and the blood, lymph (kaph)¹⁰⁴ and tissue fluid (rasa).¹⁰⁵ Blood is a group of similar tissues specialized to perform certain functions. In addition to transporting food and oxygen to cells and removing waste products from them, according to modern Biology, blood has the following functions : "it transports hormones, the secretions of the endocrine glands ; it has a role in regulating body temperature, cooling organs such as the liver and muscles where excess of heat is produced and heating the skin where heat loss is greatest ; its white cells are a major

91. Ācārāṅga Sūtra II. 4 (śoṇita); Sūtrakṛtāṅga II. 2.18; Bhagavatī Sūtra 1.7.61; Tandula Veyāliya 2, p. 6.

92. Tandula Veyāliya 16, p. 35.

93. Kalyāṇakāraka, Ugrādityācārya v. 7, p. 31.

94. "Sarīrasyādharma bhavatyāhāraḥ", Sūtrakṛtāṅga II. 3. (comm.), p. 85; Pañṇavaṇā Sutta, Āhārapadaṁ, 1814-26, pp. 395-7. "Abhikkhaṇāṁ āhārei abhikkānaṁ pariṇāme", Tandula Veyāliya, 4, p. 8. Navatattvā prakaraṇāṁ, p. 12.

95. "Abhikkhaṇāṁ usasei abhikkhaṇāṁ nisasei, etc." Tandula Veyāliya 4, p. 8.

See Ucchvāsapadaṁ, Pañṇavaṇā Sutta, p. 184. Satataṁ... ānamānti vā pāṇāṁ. āṁti vā", Navatattvā prakaraṇāṁ, Ānapāṇa Paryāpti; p. 12.

96. Tandula Veyāliya, 16, p. 35.

97. Lomāhāra means the taking of food by diffusion "Lomāhārastu śarīraparyāpt-yuttarakāla bāhyayā tvacā lomābhīrāhāraḥ" Sūtrakṛtāṅga II. 3. p. 87 (comm.)

98. Pañṇavaṇā Sutta. 1.62-68.

99. Tandula Veyāliya, 16, p. 35; Kalyāṇakāraka 3.2-3, p. 38.

100. Sūtrakṛtāṅga II. 2.18; Tandula Veyāliya 17, p. 38.

101. Tandula Veyāliya 2, p. 6; 16, p. 35; Kalyāṇakāraka, 3.2, 3, 4.

102. Tandula Veyāliya 16, p. 35;

103. Kalyāṇakāraka, 3.497, p. 40.

104. Ibid. 3.7, p. 31.

105. Tandula Veyāliya, 16, p. 35

defence against bacteria and other disease organism; and its clotting mechanism helps prevent the loss of this valuable fluid".¹⁰⁶

Blood (Śoṇita or rūdhīra or rakta) fits the definition of tissue, although it appears to be a homogeneous crimson fluid as it pours from a wound.¹⁰⁷ It permeates the whole of the body by following the network of arteries and veins,¹⁰⁸ except head-hairs, body hairs, nails, and teeth. According to Buddhaghoṣa, blood (lohitāṁ) is of two kinds, viz. stored and mobile blood.¹⁰⁹ The former "fills the lower part of the liver's site to the extent of a bowlful and by its splashing little over the heart, kidneys and lungs, it keeps the kidney, heart and lungs moist".¹¹⁰ The latter permeates the whole of the body by following the network of arteries (dhamanjālānusāreṇa) except hairs on the head and body, teeth, nails, the parts where there is no flesh, and the dry skin.¹¹¹

Jain Biology states that blood gets generated in the foetus developing in the mother's uterus in the sixth month of her pregnancy¹¹² and it nourishes the embryo. A human body contains 1/2 āḍhak of blood¹¹³. But it does not throw much light upon the composition of blood as it is analysed in modern Biology which explains that "it is composed of a yellow liquid, called plasma, in which float the formed elements; red blood cells, which give blood its colour, white blood cells and platelets".¹¹⁴

Plasma :

Although Jaina Biology does not refer to plasma which is a complex mixture of proteins, amino acids, carbohydrates fats, salts, hormones, enzymes, antibodies and dissolved gases,¹¹⁵ nevertheless its

106. Biology, p. 249.

107. Ācārāṅga Sūtra II. 4. ; Sūtrakṛtāṅga II. 2.18.

108. Tandula Veyāliya, 2, p. 6. 16, p. 33. Visuddhimagga VIII.

109. "Lohitan tī dve hohitāṇi : samīcitalohitāṇi ca samīsaraṇalohitan ca etc.

110. Visuddhimagga, VIII, 130 ; IX-72, vide Sacitra Āyurvedā, p. 76, March, 1972, Dr. Jyoti Mitra. A study of Anatomical Material in Vissuddhimagga of Buddhaghoṣa.

111. Ibid. VIII, 130 ; IX. 72

112. Tandula Veyāliya 2, p. 6.

113. "Rūdhirassa ādhāyām" Tandula Veyāliya 16, p. 35 ; Kalyāṇakāraka 3.7, p. 31. "Rakta tathārdhākamātrayuktām /".

114. Biology, 241.

115. Ibid., p. 250.

reference to fats (meda and vasā) as one of the constituent elements of plasma suggests its existence in the blood. The human body contains two anjalis of meda (hard congealed fat) and three anjalis of vasā (semi-liquid fat).¹¹⁷

The Red Corpuscles :

The very term 'rakta'¹¹⁸ (red or crimson or blood) or *soṇita*¹¹⁹ (red or blood) as used in Jaina Biology connotes blood which contains red blood cells or erythrocytes. According to modern Biology, "there are, on the average, about 5,400,000 red blood cells per cubic millimeter of blood in the adult male, and about 5,000,000 per cu. mm. in the adult female. New infants have a larger number, 6 to 7 million per cubic millimeter; this number decreases after birth and the adult number is reached at about three months; the human body contains about thirty trillion red blood cells".¹²⁰

The mention of 1 āḍhaka¹²¹ or 1/2 adhaka¹²² of blood in the human body as made by the Jainacāryas suggests the quantity of red corpuscles contained in it at different stages.

Hemoglobin :

Jain Biology does not make any direct mention of hemoglobin, but its reference to pitta¹²³ (bile pigments) which is excreted by the liver (yakṛ) in the bile as a result of the chemical degradation undergone by the heme portion of the molecule of hemoglobin¹²⁵ and also of bile, ducts or veins (sirāo pittatdhāriṇīo)¹²⁶ suggests that the Jainacāryās had some ideas or knowledge of hemoglobin in the blood. The occurrence together of the two terms pitta - soṇiya¹²⁷

116. Tandula Veyāliya, 16, p. 35; p. 40; Kalyāṇakāraka, 3.6-7, p. 31.

117. Kalyāṇakāraka, 3.6-7, p. 31; Tandula Veyāliya mentions 1/2 āḍhak of vasā, 16, p. 35.

118. Kalyāṇakāraka 3.6-7, p. 31.

119. Tandula Veyāliya 6, p. 10.

120. Biology, p. 250.

121. Tandula Veyāliya 16, p. 35.

122. Kalyāṇakāraka 3.7, p. 31.

123. Tandula Veyāliya 2, p. 6.

124. Kalyāṇakkāraka 3.4

125. Biology, p. 252.

126. Tandula Veyāliya, 16, p. 35.

127. "Chāṭhe māse pittasōṇiyām uvacīṇei", Tandula Veyāliya 2, p. 6.

in the Jaina works with their respective quantities¹²⁸ clearly shows that they are closely associated for the function of the body, such as, the transport of oxygen, etc. The pittas (bile pigments) are primarily responsible for the colour of the faeces, "if the bile duct is blocked by a gallstone, for example, they cannot pass into the intestine and the faces are a grayish clay colour".¹²⁹

Oxygen carrying Devices :

"All other mammals have red cells (śonita)¹³⁰, "similar to man's non-nucleated, bioconcave discs containing hemoglobin¹³¹. Birds (pakkhins), reptiles (parisarpas), amphibians (maṇḍukas) and fishes, (macchas) have blood (śonita),¹³² i. e. according to Biology," have oval shaped red cells which contain hemoglobin, but are nucleated".¹³³

Invertebrates (two-sensed beings, etc.) have a variety of devices for oxygen transport.¹³⁴ Modern Biology explains that "A few worms have blood cells containing hemoglobin but others such as the earth worm (i.e. nūpuraka) have hemoglobin simply dissolved in the plasma. Other invertebrates have different blood pigments; crabs and lobsters, for example, have a blue green blood pigment, hemocyanin, which contains copper instead of iron".¹³⁵ "The respiratory enzymes of all cells, both plant and animal, the cytochroms.....heme proteins closely related chemically to hemoglobin".¹³⁶

White corpuscles :

Jaina Biology does not mention white corpuscles, but its reference to pus (puvva¹³⁷ or pūya¹³⁸), i. e. dead white corpuscles in the body, suggests the existence of white corpuscles in the body, suggests the existence of white blood cells or leukocytes in the blood as one of its constituent elements in some form, all of which differ considerably

128. Tandula Veyāliya 16, p. 35, ; Kalyāṇakāraka, 3.7.

129. Biology, p. 252.

130. Ācārāṅga Sūtra II, 4. (Śonita) ; Sutrakṛtāṅga II. 2.18.

131. Biology, p. 253,

132. All vertebrates have blood.

133. Biology, p. 253.

134. They do it by diffusion. See Pañṇavāṇī, Ussāsapayām 697-698, p. 184.

135. Biology, p. 253

136. Ibid.

137. "Puvva", Tandula Veyāliya, p. 40

138. "Pūo", Ibid, p. 43.

from red cells. "The chief function of the white cells is to protect the body against disease organism."¹³⁹

Blood Blatelets :

They are not clearly mentioned in Jaina Biology, but the reference to blood of dead movable living beings¹⁴⁰ implies the suggestion that this third type of formed elements of the blood are important in initiating the process of blood clotting. "They are colourless, spherical, non-nucleated bodies about one third the diameter of a red cell".¹⁴¹

The Circulatory system :

The circulatory system is the transport system, for it carries food and oxygen (ucchvāsavāyu) to all the tissues (peśis) of the body,¹⁴² removes the waste products of metabolism (muttapurisa, etc.).¹⁴³ According to Biology, it "carries hormones from endocrine glands to their target organs and equalizes body temperatures",¹⁴⁴

The circulatory system includes heart (hiyayam),¹⁴⁵ the blood vessels (Śirās, dhamanis, śrotas),¹⁴⁶ ḥāru,¹⁴⁷ etc. and the lymph vessels¹⁴⁸ in addition to the blood,¹⁴⁹ lymph (Simbha)¹⁵⁰ and tissue fluid (rasa),¹⁵¹ i. e. it include arteries with capillaries, veins, nerves, lymphatic vessels, etc.

139. Biology p, 253,

140. Sūtrakṛtāṅga II. 2,18

141. Biology, p, 255

142. "Imammi Sarirae saṭṭhi sirāsayam nābhippabhavaṇam...rasaharaṇiotti vuccanti", etc. Tandula Veyāliya, 16, p. 35

143. "Imassa Jāmūṣsa saṭṭhisirāsayam nābhippabhavāṇam ahogāmiṇīṇam gudappa-viṭṭhāṇam jāṇam si nirūvaghāeṇam müttapurisavāukamam pavattai /", IbId, 16, p, 35

144. Biology, p, 362.

145. Tandula Veyāliya 16, p. 35.

146. Tandula Veyāliya 2, p. 6; 16 p. 35 (śirās) ; Kalyāṇakāraka, 3.2, p. 30 (Śirās) Tandula Veyāliya 2, p. 6 (nava dhamanis) ; Kalyāṇakaraka 3.3 (2nd dhamanis) Kalyāṇakāraka 3.4 (8 Srotas).

147. "Navaṇhārūsayām" – Tandula Veyāliya, 16, p 35

148. "Paṇavisaṇm sirāo simbhadrhārinjo" Tandula Veyāliya 16, 5 or Kaphasthma, Kalyāṇakāraka.

149. Tandula Veyāliya 16, p. 35.

150. Tandula Veyāliya, 16, p. 35 (Simbha)

151. Tandula Veyāliya 16, p. 35 (Rasa)

To understand how the system operates as an integrated unit, a brief study of the structure and function of each of the organs involved should be made according to Jaina Biology in comparison with the circulatory system of the Suśruta and Caraka.

The Blood Vessels :

There are mainly three types of blood vessels : Śirās¹⁵², dhamanis¹⁵³ and srotas¹⁵⁴, (veins, arteries currents). Śirās and dhamanis are distinguished from each other by the direction of the flow of blood and nutrient. The Jainācāryas state that there are seven hundred śirās,¹⁵⁵ nine^{155a} twenty four dhamanis¹⁵⁶ and eight srotas¹⁵⁷ (currents), nine srotas¹⁵⁸ (Navasoe purise ikkārasasoyā itthiyā) of man are orifices, not currents.

Śirās :

The seven hundred śirās take their rise from the umbilical region. Out of them one hundred sixty śirās go up to the head, they are called rasaharaṇiyā śirās. There take places the strength of eyes, ears, nose and tongue by their non - injury, while the strength of eyes, ears, nose, and tongue gets destroyed as a result of their injury. In the body another group of one hundred and sixty śirās rising from the naval region go down to the feet, there occurs the strength of the Janghā (shanks) by their non-injury ; if they are injured, there takes place headache (sisavedanā), megraine (addhasisa-veyanā), newralgic pain in head (matthayasūla) and eyes become blind (acchini amādhijjamāti).¹⁵⁹

Another group of one hundred sixty śirās taking their rise obliquely from the naval region runs to the palms of hands; there takes place the strength of arms by their non-injury, but there occur side - (lateral) pain, backache, hypochondrial pain and colic pain in hypo - chondria as a result of their injury. Another group of one hundred sixty śirās originating from the naval region go down to the rectum.

152. Tandula Veyāliya 2, p. 6. 16, p. 35 ; Kalyāṇakāraka 3.2, p. 30

153. Tandula Veyāliya, 16, p. 35, 2, p. 6 ; Kalyāṇakāraka, 3.3, p. 30

154. Kalyāṇakāraka 3.4, p. 31.

155. Tandula Veyāliya 2, p. 6 ; 16, p. 35

155a Ibid 16, p. 35

156. Kalyāṇakāraka 3.3, p. 30

157. Ibid 3.4, p. 31. They are not orifices but current.

158. Tandula Veyāliya, 16, p. 35.

159. Tandula Veyāliya, 16, p. 35.

There takes place easy excretion of urine, stool, gas (wind) on account of their non-injury, while there occur piles with bleeding and jaundice due to the retention of urine, stool and wind (or gas) caused by the injury of these śirās. There are in the human body twenty five bile-carrying śirās (śirāo dhāriṇio), twenty five lymph carrying śirās (śirāo simbhadrāhiṇio) and the seminal śirās (ducts) (dasa śirāo Sukkadhāriṇio). Man has got seven hundred śirās, woman 670 Śirās and the neuter śirās 680¹⁶⁰ respectively. The Indian Āyurveda defines more clearly the blood vessels and explains their functions which are briefly sketched in Jaina Biology.

The Suśruta¹⁶¹ gives an account of the number and functions of śirās, together with their four divisions, viz. (1) the arteries for conducting the blood, (2) lymphatics for conducting the lymph (Kaph), (3) a class of bile ducts (pittanāḍi) and (4) a class of ducts for the airs, the current (srotas) which do the work of automatic and reflex machinery of the living organism. In each division there are stated to be ten śirās which get sub-divided into 175 cords and "further ramify minutely all the body even as a network of minute fibrils covers the leaf of a tree."¹⁶²

According to both Jaina Biology and the Suśruta, the functions of the different groups of śirās are to transport (i. e. to circulate) the arterial blood, the lymph, the bile and the vital air currents respectively to the different tissues of the body. The śirās function "like the conduits of the flowing water in a pleasure house (a garden) or the channels of irrigation which transport water to the field and flood it".¹⁶³

The circulation of "the fluids and currents is effected by an alternate dilation and contraction of the vessels, the systolic movement differing according to the nature of the fluid propelled".¹⁶⁴

160. Tandula Veyāliya, 16, p. 35.

161. *Sapta Śirāśatām bhavanti, yābhīridāṁ śarīramārma iva jalāhārinibhiḥ kedāra iva ca kulyābhīrūpasnīhyate anugṛhyate cākuñcanaprasāraṇādibhirvīśeṣaiḥ //* Drumapatrasevanināmiva ca tāsāṁ pratānāstasāṁ nābhīrmūlāṁ tataśca prasānt yūrdhvamadbastiryak ca // 2 //,

Sarīrasthāna, Suśruta, 7th Chapter p. 504.

162. Positive Sciences of the Ancient Hindus, p. 210.

163. Suśruta, Sarīrasthāna, Chapt. VII.

164. "Anugṛhyate cākuñcanaprasāraṇādibhirvīśeṣaiḥ //". Ibid.
See Positive Sciences of the Ancient Hindus, p. 210

Dhamanīs :

According to Jaina Biology, there are stated to be twenty-four dhamanīs in the human body. Out of them twenty dhamanīs are situated around (i. e. on the above and below) the naval point and four are obliquely (or horizontally) placed.¹⁶⁵ In agreement with this number of dhamanīs mentioned in the Kalyāṇakāraka with their three groups, the Suśruta also divides them into three groups, (viz. (1) ten trunks or cords going up to the heart, thence to the head, (2) ten going down to the intestines, kidneys and rectum, and (3) four branching over the whole body. It is clear from the accounts of dhamanīs given by Kalyāṇakāraka and Suśruta that they take their rise from the umbilical cord.

First group of Dhamanīs :

According to the Suśruta, each of the ten ascending dhamanīs trifurcates, and proceeds to the head, first on going to the heart.¹⁶⁷ Of these one pair conducts each of the four sensory currents (those of sound, colour, taste and smell) from the sense-organs to the heart, the seat of consciousness for them (hṛdayam viśeṣeṇa cetanāsthānam).¹⁶⁸ Other dhamanīs conduct automatic motor currents (e. g. the currents concerned in respiration) yawning, sleeping and waking or the secretions of the lachrymal and mammary glands.¹⁶⁹

The second group of Dhamanīs (Adhogāmini) as described in the Suśruta :

165. Kalyāṇakāraka 3.3, p. 30.

166. "Caturvimsatirdhamanyo nābhīprabhavā abhihitāḥ // 2 //";
"Tāśāṁ tu nābhīprabhavāṇāṁ dhamanīnāmūrdhvagā daśā daśā cādhogāminyaś-
catasraśtiryagāḥ // 3 //"; Sarirasthāna, Suśruta, Chapter 9.

167. Urdhvagāḥ śabdasparsārūparasagandhapraśvasocchvāṣejmbhitakṣuddhasitakathī-
taruditādinviśeṣānabhivahantyāḥ śarīram dhārayanti | tāstu hṛdayamabhiyora-
pannāstridhā jayante tāstrīmśat | tāśāṁ tu vātāpittakaphasoñitarasān dve dve
Vahatāstā daśā | śabdārūparasagandhāṇāṣṭābhīrgñīte dvābhyām bhāsate dvā-
bhyām ghoṣām karoti, dvābhyām svapite dvābhyām pratibudhyate ca dve
caśruvāhīnyau | dve stanyām striyā vahataḥ stanasaṁśreite | teeva śukram narasya
stanābhyāmabhiyahataḥ tāstvetāstrīmśatsavibhāgā vyākhyatā etābhīrūrdhvam
nābherudarapārśvapṛṣṭhoraskandhāgrīvābāhavo dhāryante yāpyante ca |";
Sarirasthāna, Suśruta, Chapter 9.

168. "Hṛdayam Viśeṣeṇa Cetanāsthānam |"
Sarirasthāna, Suśruta, ch. IV, p. 468,
"Hṛdayam cetanādhiṣṭhānam ekam |"
Caraka, Sarirasthāna, Chapter VIII

69. Suśruta, Sarirasthāna, Chapter 9

The descending dhamanis run down to the intestines (pakkāśaya - bhūtānyam Sthūlāntrapamtiḥ);^{169a} a kidneys (mūtrāśaya), bladder and rectum, and transport, in pairs as before, urine and other secretions and excreta and also the chyle from the small intestines to the ascending as well as the ramifying dhamanis. In addition some of them conduct sweat to the ramifying dhamanis¹⁷⁰.

The Third group: Tiryak Dhamanis :

The four dhamanis called tiryak dhamanis ramify obliquely over the body into millions of fibres and fibrillae, which terminate in the pores of the skin. Their function is to conduct the sensory currents of touch to the central organ of the heart (including the internal organic sensations) from all parts of the periphery. As a result of their connection with the pores of the skin "they transport sweat outwards and the influences of baths, embrocations, and fomentations inwards".¹⁷¹

Although Jaina Biology does not clearly explain the functions of dhamanis, nevertheless it is suggestive from the mention of equal number of 24 dhamanis that they carry on the same functions as explained in the Suśruta.

Srotas (currents) :

As pointed out, Jaina Biology mentions eight srotas.¹⁷² In agreement with this view the Suśruta states that the chyle, the blood, the vāyu (oxygen), the metabolic fluid (pitta), the lymph (kaph), the

169a Ibid.

170. Adhogamāstu vātamūtrapuriśuśukrārttavādinyadho vahanti / tāstu pittāśayamabhipratipannāstastrasthamevānnapānarasam vipakkamauṣṇyādvivecayantyo abhivahantyāḥ śarīram tarpayantyarpayanti cordhvagatānām tiryaggatānām rasasthānam cābhiḥ ūrayanti mūtrapuriśasvedāṁśca vivecayantyāmapakkāśayāntare ca tridhā jāyante tāstriṁsat / tāsām tu vātapittakaphaśonitarasān dve dve bahastā daśā / dve annavahinyāvantrāśritā ... upto pakkāśayakāimūtrapuriśagudabastimedhrasakthīnidhāryante yāpyante ca" 5 Śārirasthāna, Suśruta, Chapter 9.

171. Tiryaggānām tu catasrīnām dhamanīnāmaikaikā ḥatadhā sahasradhā cottarottaram vibhajyante tāstvāsamīkhyeyāstabhiridam śarīram gavākṣitām vibaddhamātataṁ ca / taśām mukhāni romakūpaprati�addhānī yaih svedamabhivahanti rasam cāpi santarpayantyantarbahisca ; taireva cābhyaṅgapariṣekāvagāhalepanaviryāṇyantajśarīramabhipratipadyante tvaci vipak্কāni taireva spargasukhamasukham vā gṛhṇāti / tāstvetāścasasro dhamanyah sarvāṅgagatāḥ savibhāgā vyākhyātāḥ" 1.6, Śārirasthāna 9, Suśruta.

172. Kalyāṇakāraka, 3.4, p. 31.

fat (meda), the marrow (majjā) in every part of tissue of the body is supposed to be connected by subtile srotas with the same kind of fluid or tissues in every other part.¹⁷³

Here also the function of eight srotas of Jaina Biology is supposed to be the same as those of right Srotas of the Suśruta.

The Vascular system :

The anatomical arrangement of śirās and dhamanis and srotas is so obscure in Jaina Biology that only a rough sketch of its general features may be presented on the basis of the views of Caraka and Suśruta regarding them. Both Jaina Biology¹⁷⁴ and Caraka-Suśruta¹⁷⁵ give the number of śirās as seven hundred, while the number of dhamanis is mentioned as twenty four in Jaina Biology¹⁷⁶ and Suśruta¹⁷⁷ as two hundred in Caraka¹⁷⁸ which estimates the ramifications as numbering 3,056,900.¹⁷⁹

The Heart (Hṛiyaya)¹⁸⁰ :

The heart is a powerful muscular organ located in the chest under breast bone. In the Sangitaratnākara the heart is stated to be lotus-shaped (hṛidayam - pañkajākṛiti)¹⁸¹. It is considered to be the seat of waking consciousness, for it expands during waking life and contracts during sleep.¹⁸² According to Visuddhimagga, heart is located "inside the body near the middle of the frame of the ribs (uraṭhi-pañjaramajjhām) like a piece of meat placed near the framework of an old cart".¹⁸³ "It is the colour of the back of a red lotus petal,

173. Tāni tu prāṇānnodakarasaraktamāṁsamedomūtrapurīsaṅkṛartavavahāni yeś-
vadhikāra ekeśāṁ bahūni / upto tayormulāṁ śnayutvacaṁ raktavahāca
dhamanyastatra viddhasya svayathurmāṁsaśoṣāḥ śirāgranthbayo maraṇām ca'/'
etc. 8 Sarirasthāna, Suśruta, Chap. 9.

174. Tandula Veyāliya, 2. p. 6 ; 16, p. 35; Kalyāṇakāraka 3.2, p. 30

175. Suśruta, Sarirasthāna, Chapter 7 ; Caraka Sarirasthāna Chapter 7, p. 383.
(Saptasiraśatāni).

176. Kalyāṇakāraka, 3.3, p. 30.

177. Suśruta, Sarirasthāna, Chapter 9 "Caturvinīśatirdhamanyo"

178. "Dve dhamanīśate", Caraka, Sarirasthāna, 7, p. 338.

179. Caraka, Sarirasthāna, 7.

180. Tandula Veyāliya, 16, p. 35.

181. "Hṛidayam pañkajākṛiti /" Sangīta Ratnākara V. 82, Diṇḍotpatti, vide Positive Sciences of the Ancient Hindus, p. 225.

182. Suśrām syādadhovaktrām etacca cetanāsth ānām nimilati svapityātmā jāgariti
vikasatyapi, Ibid. vv. 83-84, Piṇḍotpatti, Svarādhyāya

183. Visuddhimagga XI, 59. "Hadaya sarirabbhantare uratth/pañjaramajjhāmnissāya
thitām /"

having the shape of lotus and with the outer petals removed and turned upside down, it is smooth outside and inside like the interior of Kosataki or spongy gourd (*Luffa aegyptiaca*). Inside it there is a hollow, the size of a punnāga seed's bed where half a pasata¹⁸⁴ (Sanskrit *prasṛti*) measure of blood is kept".¹⁸⁵ According to Jaina Biology, heart is a hollow muscular organ measuring 3 1/2 palya.¹⁸⁶ It is situated "in the thorax between the lungs and above the central depression of the diaphragm. It is about the size of the closed fist; shaped like a blunt cone, and is directed upward, backward and to the right".¹⁸⁷

According to modern Biology, "the heart of man and other mammals and of birds is divided into four chambers, the upper right and the atria (auricle) and the lower right and left ventricles. The atria, which have relatively thin walls, receive blood from the veins and push it into the Ventricle. The latter, with much thicker walls, pump the blood out of the heart and around the body".¹⁸⁸

Routes of the Blood around the Body :

To understand how the circulatory system carries material from one part of the body to another, some knowledge of how the blood vessels (*Śiras* and *Dhamanis*) are connected is necessary. In any particular vessel blood flows, in one direction only. The circulation of the blood is made by two sets of vessels—*Śiras* (veins) and *Dhamanis*—arteries.¹⁸⁹ The entire vascular system takes its rise from the naval point in the foetus. From this central alimentary tract there originate these two sets of vessels¹⁹⁰ for the transportation of the blood.

The blood—Vascular System :

As pointed out, the blood Vascular system of Jain Biology can be understood in the light of Brāhmaṇical Biology. There are two classes

184. According to metric measurement, *prasṛti* signifies 93, 312 miligrams, vide, J. R. T. M., Vol. I. No. 2. p. 275, See *Sacitra Ayurveda*, March, 1972 p. 78.

185. *Visuddhimagga*, VIII, Haddyā ... cāssa punnāgāṭhi ... addhapasatamattani Lohitaṁ etc."

186. *Addhūṭhapaliyāṁ hiyayāṁ*", *Tandula Veyāliya*, 16, p. 35. ; "hṛdayantara vartimāṁsakhaṇḍāṁ sārdhapalatrayāṁ bhavāti |",

187. *Anatomy and Physiology*, p. 341 *Ibid*, p. 36.

188. *Biology*, p. 264

189. *Tandula Veyāliya* 16, p. 35. Imūmī sarīrae saṭṭhisirasayāṁ nābhippābhavāṇām ; *Ibid* 2, p. 6.

190. *Ibid*, 16, p. 35

of blood transporters or conductors, viz. “(1) Sirās (veins) which break up into capillaries¹⁹¹ (pratāna) and circulate pure blood from the liver (yakṛt) and spleen (Plihā)¹⁹² to the heart (hṛdaya) and from the heart to the rest of the body,¹⁹³ and (2) “Dhamanis (arteries?) which run, (two from the intestinal tract-portal vein and inferior vena cava)¹⁹⁴ and “two from the heart (superior vena cava and pulmonary artery?)”¹⁹⁵”.

“The “Venous” blood (chyle-mixed blood) circulates from the alimentary tract (gastric and intestinal vessels) along a Dhamanī trunk (portal vena cava?) to the liver (and spleen), where the chyle gets a red pigment and is converted into (Pure) blood. From the liver and spleen, Sirās run to the heart. The liver (and spleen, a minor blood-vascular gland) and the heart are the centres of origin of the sirās and circulate pure blood by their means over the entire body.”¹⁹⁶

Arrangement of the blood bearing Sirās and Dhamanīs :

“Two blood -- transporting Dhamanīs trunks (Veins) run from the heart (Superior vena cava and pulmonary artery?), and two run from different regions of the alimentary tract (portal vein and inferior vena cava?). Ten Sirās bearing pure blood proceed from the alimentary tract to the liver and spleen, which are joined on to the heart by means of both Sirās and Dhamanīs, “The ten Sirās are subdivided into 175 branches, which are distributed over the body in the same way as the lymph - bearing Sirās”.¹⁹⁷

It is clear from the reference to lungs (phopphasa phephas)¹⁹⁸ in Jaina Biology that the Jainācāryas had knowledge of the role played by the lungs in the purification of the blood.

The liver (yakṛt) converts “Venous blood” in this system into true arterial blood, and along with the spleen (plihā) as a basis of

191. It suggests from the blood vascular system that there are capillaries.

192. Tandula Veyāliya, 17, p. 38. ; Kalyāṇakāraka 3.4., p. 31.

193. Asṛgvahāśca rohinyaḥ śirāḥ nātyuṣṇaśitataḥ”. Saṁrasthāna, VII ; Suśruta.

194. Kalyāṇakāraka, 3.3, p. 30. See Tandula Veyāliya 16, p. 35 ; Positive Science of the Ancient Hindus, p. 215

195. Positive Science of the Ancient Hindus, p. 215.
“Raktavāhinyaśca Dhamanya”, Saṁrasthāna, 9 Suśruta.

196. Positive Sciences of the Ancient Hindus p. 215

197. Positive Sciences of the Ancient Hindus, p. 215.
see Saṁrasthāna 7, 8, 9, Suśruta.

198. Tandula Veyāliya 17, p. 38

discrimination between a Śirā and a Dhamanī, "thus illustrating Suśruta's statement that the distinction between these two kinds of blood vessels must be accepted as real inasmuch as they have different sources and different functions."¹⁹⁹

Foetal Circulation :

A foetus developing in the uterus cannot obtain food or air directly, its stomach and lungs are non-functional.²⁰⁰ It obtains food and oxygen (vāyu) from the material blood by means of blood vessels in the placenta and umbilical cord (Putrajivarasaraharani).²⁰¹ There is, however, no direct connection between the blood streams of mother and foetus. The blood of the foetus is manufactured within its own body,²⁰² chiefly, in the spleen (plihā) and liver (yakṛt). It is stated in Jaina Biology that the foetus developing in the mother's womb collects whatever food substance it obtains from the mother's body²⁰³ and transforms the same into the forms of ear, eye, nose, tongue, skin, bone, marrow, hair, beard, hair on the body and nail.²⁰⁴

The foetus absorbs abundant food by its entire self, but not by the mouth and transforms it, inhales and exhales air again and again,²⁰⁵ for mātṛjivarasarahaṇī and putrajivarasarahaṇī are joined together by mātṛjivarasarahaṇī and connected by putrajivarasarahaṇī mutually²⁰⁶. It absorbs food-substance through putrajivarasarahaṇī (umbilical cord) and transforms the same into various parts of the body.²⁰⁷ There

199. Positive Sciences of the Ancient Hindus, p. 216

; See Sārīrastha 9. Suśruta for distinction between śirñ and dhamanī.

200. Bhagavati 1.7. 61-2. ; Tandula Veyaliya, 4, p. 9.

"Jive nām gabbhagae samāñe savvao āhārei savvao pariṇāmei savvao usāsei savvao nīsāsei abhikkhaṇam āhārei abhikkhaṇam parināmei abhikkhaṇam usāsei abhikkhaṇam nīsāsei āhārei, āhacca pariṇāmei āhacca usāsei āhacca nīsāsei māujivaraśaharāṇī puttajivarasarahaṇī māujivaraśaharāṇī puttajivām phuḍā tamhā āhārei tamhā pariṇāmei avaraṇī nām puttajivām phuḍā tamhā cinai a pahu muheṇam kāvaliyam āhāram āharittae "

201. Ibid, 4, p. 9

202. "Chaitthe māse pittasoniyam uvaciṇei |", Tandula Veyaliya 2, p. 6.

203. "Jām se māyā nāṇāvihāo nava rasavigaio tittakaḍukasāyaṁbilamahurāṁ dāvāṁ āhārei tao egadeṣenāṁ oyamāhārei", Tandula Veyaliya, 5, p. 9; Bhg. 1.7.61

204. Bhagavati, 1.7.61 "Jive nām Gabbhagae samāñe jām āhāram āhārei ciṇāte soimdiyāttae up to nahattāe |" Tandula Veyaliya, 3, p. 7.

205. Tandula Veyaliya 4, p. 9 Bhagavati, 1.7. 61-62.

206. Ibid.

207. Tandula Veyaliya, 4, P. 9.

is also the other cord bound by putrajivarasarahaṇī and connected by māṭṛjivarasarahaṇī through which the foetus receives food substance.²⁰⁸ That is to say "within the placenta the capillaries of mother and foetus (i. e. māṭṛjivarasarahaṇī and putrajivarasarahaṇī come into close contact, and substances pass from one to the other by diffusion or by active transport process, oxygen and food substances pass from the maternal to the foetal blood - vessels and carbon dioxide and metabolic wastes pass from the foetal to the maternal blood vessels",²⁰⁹ as it is said that the foetus does not pass urine, stool, etc.²¹⁰ "The two umbilical arteries (i. e. putrajivarasarahaṇis), grow out of the lower part of the aorta of the foetus and pass to the placenta (i. e. māṭṛjivarasarahaṇis). Blood is returned to the child by a single umbilical vein which passes through liver and empties into the inferior vena cava".²¹¹ The fact that the lungs (Phopphasaphephasa) which are not mentioned clearly as developed in the foetus²¹² are small and non-functional presents a special problem, "for the capillaries in the uninflated lungs can accommodate only a fraction of the blood flowing through the heart, the rest must bypass the lungs until after birth."²¹³

The Lymph System :

In addition to the blood circulatory system the body is equipped, according to Jaina Biology, with a similar, independent group of vessels²¹⁴ constituting the lymph system (Simibha or Kaph system). But Jaina Biology does not throw much light on the details of this system except some of its features and functions. It is known from Jaina Biology²¹⁵ and other Indian sources²¹⁶ that "the circulation of the lymph is also made by two sets of vessels Śirās and Dhamanīs.

208. Tandula Veyāliya, 4, p. 9.

"Māujivarasarahaṇī Puttajivarasarahaṇī māujivapāḍibaddhā puttajivāṁ phuḍā 1.7 etc.

209. Biology, p. 271

210. Jivassa . . . gabbhagayassa samāṇassa - atthi uccārei vā pāsavnei vā no iṇaṭṭhe samāṇṭhe |", Tandula Veyāliya, 3, P. 7. ; Bhagavatisūtra 1, 7, 61-62.

211. Biology, p. 221.

212. Tandula Veyāliya 2, P. 6.

213. Biology, P. 272.

214. "Paṇavisaṁ Sirao simbhāḍhāriṇio", Tandula Veyāliya, p. 16, p. 35

215. Tandula Veyāliya, 16, p. 35. ; Kalyāṇakāraka 3.2-3

216. Caraka, Sarirasthāna, Ch. 7 ; Suśruta, Sarirasthāna Ch. 7.

From the Central alimentary tract of the naval point there originate two sets of blood vessels (Śirās and Dhāmanīs – Rasavāhinyāḥ), for the transportation of the chyle and other lymph".²¹⁷

The Lymph (Kaph or vāta) and Chyle (rasa)

It is further explained that "the chyle is conducted by the chyle-bearing Dhāmanīs (Rasavāhinyāḥ) and the lymph (kaph) by the lymph-bearing Śirās and Dhāmanīs (kaphavāhinyāḥ). The lymph bearing śirās comprise ten branches²¹⁸ at the origin, and ramify into 175, viz. 25 in each leg, 25 in each arm, 8 in the pelvic cavity, coccyx, penis, etc., 2 in each side, 6 in the back, 6 in abdomen, 10 in the breast, 14 in the neck, 4 in the ears, 9 in the tongue, 6 in the nose, and 18 in the eyes".²¹⁹

"The chyle is transported by another system of vessels (Rasavāhinyāḥ Dhamanyah). The chyle ducts originate from the naval point (possibly the receptaculum chyle in this case). A Dhāmani trunk goes down to the small intestine, and carrying the chyle, proceeds upwards towards the heart (thoracic duct?). Two chyle ducts and two lymph ducts (Dhāmanīs – Rasavāhinyāḥ and Kaphavāhinyāḥ) proceed from the heart, and ramify over the head and trunk. In the same way two chyle ducts and two lymph-ducts run from the intestinal tract and ramify over the pelvic region. Four obliquely branching Dhāmanīs (Tiryak Dhāmanīs transporting chyle, sweat, and internal secretions) spread from the central system and ramify in numberless minute channels over the limbs and the body".²²⁰

The views of Jaina Biology, rather Indian Biology, are indirectly supported by modern Biology in the following manner :

"In addition to the blood circulatory system the body is equipped with a similar, independent group of vessels constituting the lymph system. These carry the clear, colorless fluid, lymph which, like tissue fluid is derived from blood and resembles it closely. It contains much less protein than does blood and has no red cells. It does contain white cells, some of which enter the lymph capillaries from the tissue

217. Caraka, Śarīrasthāna, Ch. 7; Suśruta, Śarīrasthāna, Ch. 7.

218. "daśa Kaphavahinyo" Śarīrasthāna, Suśruta.

219. Positive Science of the Ancient Hindus, P. 214. "Tatra vātavāhinyah śira ekasmin sakthni pañccavimśati ...aṣṭauvatrayo /" .. evam .. Kaphavahāsca /". Śarīrasthāna 7, Suśruta.

220. Ibid. p. 214.

"Tiryaggānām tu catasṛṇām dhāmanīnām ikaika satadhā sahasradhā rasa in cāpi santarparpyantyantarbahisca /" Śarīrasthāna ,/ 5, Suśruta.

fluid, others of which are manufactured in the lymph nodes. In other respects lymph is similar to blood".²²¹

Functions of the lymph system :

"The lymph system performs four functions : First, it assists in returning tissue fluids to the blood circulatory system. The second and third functions are the production of lymph-cytes and the filtering of dust and bacteria. A fourth function is the absorption of fats which is accomplished by the lymph vessels that drain the intestines".²²²

Circulation in other Organisms :

All organisms have the same problem of transporting substances from one part of the body to another. Two - sensed animals (i. e. Protozoa) have no special system for bringing about circulation of substances ; "foods, wastes and gases simply diffuse through the cytoplasm and eventually reach all parts of the cell"²²³ (i. e., *tvacāhāra* and *lomāhāra*).²²⁴ In most two-sensed animals it is suggestive that the process is aided by movements of cytoplasm".²²⁵ Modern Biology which explains "as *amaeba* moves along, the cytoplasm streams from the rear to the front of the body, distributing substances throughout the cell, etc."²²⁶ "In the earth-worm and similar forms there is a definite circulatory system, consisting of plasma, blood cells and blood vessels, although the latter are not specialized as arteries, veins and capillaries.

The larger and more complex invertebrates (i. e. four-sensed animals), such as, insects (*Kīṭa*), etc., all have a circulatory system consisting of a heart, blood vessels and blood cells,²²⁸ etc. The circulatory systems of all vertebrates, i. e. five-sensed animals are fundamentally the same,²²⁹ from fish (*matsya*) and frogs (*maṇḍukas*) through lizard (*gṛhagolikā*) to birds (*pakṣin*) and man (*manuṣya*). All have a heart and an aorta as well as arteries, capillaries and veins, organized on a similar basic plan".²³⁰ In the evolution of the higher vertebrates, such as man, from the lower, fish-like forms, the principal changes in the circulatory system occurred in the heart and are correlated with the change in the respiratory mechanism from gills to lungs".²³¹

221. Biology, P. 278.

222. Biology, P. 279, Tandula Veyāliya 16, P. 35.

223. Biology, P. 279.

224. *Sūtrakṛtāṅga* II. 3. *Sarīrēṇoyāhāro tayāya phāṣeṇa lomāhāro /*", P. 86.

225. Biology, P. 279.

226. *Sūtrakṛtāṅga* II. 3, P. 86 (*Tvacāhāra* and *lomāhāra*)

227. Biology, P. 279.

228. Biology, P. 280.

229. Tandula Veyāliya 16, P. 35.

230. Biology, P. 280.

231. Biology, P. 280.

(Second Section)

The Respiratory System

The energy for all the myriad activities of animals is derived from reactions of biologic oxidations, i. e. chemical reactions of air by *ucchvāsaparyāpti*¹ (vital force by which particles of respiration are taken in, oxidized for energy and left out as carbon dioxide and water). The energy making process in the presence of air (oxygen) is called respiration (*āṇapāṇa* or *ussāsanisāsa*).² Respiration³ is one of the *par-yāptis* and *prāṇas* (vital force and life forces) of beings, as mentioned in the beginning. It starts in the human foetus, while developing in the mother's womb.⁴ But its lungs are non-functional at this stage. According to both Jaina and Brāhmaṇical⁵ Biologies, the essential feature of these reactions of biologic oxidation is the assimilation of food, the transfer of *rasa* (chyle or nutrient)⁷ from one molecule to another, i. e. "the transfer of one molecule, the hydrogen donor, to another, hydrogen acceptor, etc."⁶ In most animals there is a series of compounds each of which accepts *rasa*⁷ "(i. e. hydrogen) from the preceding and donates it to the subsequent one".⁸ The ultimate *rasa*-acceptor in the metabolism of

1. "Ābhāra sarira īmīdiya, usāsa vāu maṇo bhinivattī / Hoi jao daliyāu, Karanām, pai sāu pajjatti //” Br̄hatsaṅgrahaṇī, v. 313, ed. by Amṛtlal Puruṣottamadas vs. 1993. “Yayocchvāsārhamādāya dalaṁ pariṇamayya ca / Tattayālambya muñcetso-cchvāsaparyāptirucyate (22)” Lokaprakāśa I, 3.22, p. 66. ; or “Āṇapāṇa Pajjatti” Navatattvaprakaraṇām. v. 6, p. 12. ; Gommaṭasāra, Jiva kāṇḍa, 119.
2. Navatattvaprakaraṇam V.6., p. 12 (āṇapāṇa) ; Gommaṭasāra (Jiva), 119 (āṇapāṇa) ; Viśeṣavaśyaka Bhāṣya, V. 274. “Usāsaya-nisāsaya”
3. Tandula Veyāliya, 4, pp. 4-9. ; Navatattvaprakaraṇām. v. 6, p. 12 (Paryāpti) ; Gommaṭasāra, (Jiva), vv. 118, 119, etc, (Paryāpti). ; Jivavicāra vv. 42-43 (Prāṇa) ; Gommaṭasāra Jivakāṇḍa, v. 130 (Prāṇa) ; Tattvarthadhigama Sūtra, V. 19 (Prāṇa), apāṇa VIII. 12 (Bhāṣya).
4. Bhagavatī Sūtra, 1. 7. 61. ; Tandula Veyāliya 4, pp. 8-9 (usāsanisāsa). Prāṇast-athāpānasamāṇasamājnāu / vyāno apyathodāna iti praddiṣṭāḥ pañcīcaiva vāyava nityamāhāranihāra viniṛgamārthāṇ. Kalyāṇakāraka 3.9.
5. “Tatraiśāhāraparyāptiryādāya nijociṭam / ; pṛothak-Khalarasatveñāhārañpari-ṇatiñ nayet” // Lokaprakāśa, Pt. I, 3rd sarga. v. 17
6. Saṅgītaratnākara, Saṅgadeva, Vol. I Chapter I, vv. 60-67; the functions of prāṇavayus, viz. prāṇa up to apāṇa, are explained there.
7. Kalyāṇakāraka 3.9 ; Lokaprakāśa, Pt. I, 3. vv. 17-22.
8. Biology, p. 283.

animals is air (oxygen – ucchvāsa)⁹. The term ‘āṇapāṇa’¹⁰ or usāsa-nisāsa¹¹ or prāṇapāṇa¹² (respiration) is used by the Jainācāryas to refer to those processes by which animal (and plant cells) utilize oxygen (usāsa), carbon-dioxide (nisāsa) and convert energy into biologically useful forms. The term “āṇapāṇa or usāsa – nisāsa” has different meanings in Jaina Biology. It is synonymous with breathing and means inhaling and exhaling. It becomes clear from the reference to the usage of this term that it is applied to the important process of the exchange of gases between the cell and environment. Finally, as the details of cellular metabolism by āṇapāṇa or ucchvāsaparyāpti became known, the term “āṇapāṇa or usāsa–nisāsa” is used to denote those enzymic reactions of the cell which are responsible for the utilization of oxygen (usāsa?).

Direct Respiration :

The exchange of gases is a fairly simple process in a small, aquatic animal (e.g. Jalauka, samuddalikkha and some two – sensed aquatic animals).¹⁶ Dissolved oxygen from the surrounding pond water diffuses into the cells, carbon dioxide diffuses out, no special respiratory system (lungs, etc.) is needed. Such gas exchange brought about by āṇapāṇa¹⁷ or ucchvāsaparyāpti¹⁸ of beings is the direct respiration, as the cells

9. Chyle or molecules of nutrients (rasibhūtamāhāram) are utilized by animals for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc. successively with the vital force called Sarira-paryāpti, Lokaprakāśa, Pt. 1, 3rd Sarga, p. 65.
10. Biology, p. 28.3
11. Lokaprakāśa, Vol. I, 3.22 ; Tandula Veyāliya 4.
12. Navatattvaprakaraṇa, v. 6.
13. Viśeṣāvasyaka Bhāṣya, gāthā 2714
14. Tattvārthādhigama Sūtra v, 19; VIII. 12 (Bhāṣya)
15. Ibid. v. 19 ; VIII 12 (Bhāṣya); Bhagavatī Sūtra 1.7.61. Tandula Veyāliya 4 ; Pannavaṇā Sūtra, Ucchvāsapada, 1,19.
“Prāṇapāṇapudgalagrahaṇasāmarthyajanakmucchvasanāma |” Tattvārthādhigama Sūtra – Bhāṣya’ 8–12. Urdhvagāmī samirāṇah prāṇah adhogatirapanaḥ prāṇapāṇavanatapradeśaskandhpudgalapariṇāmajanyau tadyogyapudgālanām grahanāmādānam tasya sāmarthyām – atiśayāmjanayati yat taducchvāsanāmā yasyo-dayaducchvasanīḥsvāsau bhavataḥ” T.S. Bhā., 8. 12, p. 158.
16. Navatattva Prakaraṇa 6. Two – sensed beings have fine paryāptis āhāra-sarira indriya āṇapāṇa and bhāṣa. Jalauka, etc. aquatic beings are two-sensed and have āṇapāṇaparyāpti which helps the exchange of gases in them.
17. Navatattvaprakaranam v. 6, p. 12.
18. Lokaprakāśa Pt. I, 3,22.

of organism exchange oxygen (usāsa) and Carbon-dioxide (nisāsa) directly (like lomāhāra) with the surrounding environment.

Indirect Respiration :

As animals appear to have evolved into higher, more complex forms, it became impossible for each cell to exchange gases directly with the external environment. Some form of indirect respiration involving a structure of body specialized for respiration was necessary, e.g. lungs (phopphasaphephasa).¹⁹ "For indirect respiration, fishes and many other animals developed gills",²⁰ the higher vertebrates, reptiles (parisarpas), birds (pakṣins) and mammals including man developed lungs (phopphasaphephasa).²¹ In Jaina Biology an external and internal phase in indirect respiration can be distinguished in the exchange of gases between the body cells and the environment as suggested by its reference to āṇapāṇa²² or usāsa-nisāsa²³ or prāṇapāṇa.²⁴ External respiration (prāṇa)²⁵ is the exchange of gases by diffusion between the external environment and the blood stream by means of the specialized respiratory organ, for example, lungs (phopphasaphephasa)²⁶ in the mammals including man. Internal respiration is by all means²⁷ the exchange of gases between the blood stream and the cells of the body, brought about by āṇapāṇa²⁸ or ucchvāsa²⁹ paryāpti. Between these phases the gases are transported by the circulatory system.

Structure of the Human Respiratory System :

Jaina Biology states that the respiratory system in man (and other air-breathing vertebrates) includes the lungs and suggests the existence of the tubes by which air reaches them (phopphasaphephasa).³⁰ Besides this statement, it does not go into details of the structure. The Buddhist work 'Visuddhimagga' throws some light in this respect. It is stated there

19. Tandula Veyāliya, 17, p. 38.
20. Biology, p. 284.
21. Tandula Veyāliya 17, p. 38
22. Navatattvaprakaraṇam 6, p. 12, ; Gommaṭasāra, Jivakāṇḍa, 119.
23. Tandula Veyāliya 4, pp. 8-9. ; Viśeṣāvaśyākabhāṣya, gāthā, 2714.
24. Tattvārthādhigama Sūtra, v. 19 ; (Bhāṣya).
25. Sarvārthasiddhi v. 19 (Bhāṣya).
26. Tandula Veyāliya. 17, p. 38 ; Sarvārthasiddhi v. 19 (Bhāṣya)
27. Tandula Veyāliya, 4, p. 8, "Savvāo usasei savvao nisasei"
28. Navatattvaprakaraṇam, 6, p. 12.
29. Lokaprakāśa, Pt. I. 3; 22.
30. Tandula Veyāliya 17, p. 38.

that "the lungs (Papphāsam) are located inside the body between the two breasts, hanging over the heart and liver and concealing them just as bird's nest hanging inside an old barn".³¹ "The spongy lung is divided into two or three pieces (lobes) having the red colour not very ripe (like) Udumbara fig fruits". It is shaped like "unevenly cut thick slice of cake (Visamacchinnabahalapuvakhaṇḍasamṭhāvia)".³²

The medical science describes the lungs as the cone-shaped porous and spongy organs having right and left parts. "Right lung has three lobes, while the left has two only".³³ "At birth the lungs are rose-pink - coloured, in adult life, a dark slaty mottled in patches" and with the advance of age, "this motting of its colour take up a black colour".³⁴

According to modern Biology, the structure of the human respiratory system includes, besides the two lungs, the external nares, or nostrils, nasal chamber, internal nares, pharynx, larynx, trachea or wind pipe, two bronchi, one going to each lung, bronchioles and air sacs (alveoli).³⁵ Phopphaphephasa³⁶ of Jaina Biology includes the lungs and eparterial bronchioles of trachea.

The Mechanics of Breathing :

It seems that Jaina Biology keeps clear the distinction between respiration - the exchange of gases between a cell and its environment (which in man consists of the three phases of external respiration, transportation by the blood stream and breathing, which is simply the mechanical process of taking air into the lungs (inspiration) and letting it out again (expiration)).³⁷

Respiration (prāṇāpanā)³⁸ is material. A being exhales air from the lungs. The same being inhales air from the atmosphere. These acts of respiration are helpful to the being as they enable it to live.³⁹

31. Visuddhimagga XI, 63. "Papphāsan sarirabbhantare jīṇakotṭhabbhantare lambamāno, etc.
32. Ibid. VIII. 117. "Papphāsan ti dvattiñsamāñśākhaṇḍappabhedān etc.
33. Anatomy and Physiology. pp. 92, 93.
34. Human Anatomy, Henry Gray, p. 1382, ; Vide Sacitra Āyurveda-Viśva-Āyurveda Āṅka, 6. March, 1972, p. 75.
35. Biology, p. 284.
36. Tandula Veyaliya, 17, p. 38.
37. Tattvārthādhigama Sūtra v. 19 ; VI 12. (Bhāṣya). See Sarvārthasiddhi, v. 19 (Commentary)
38. Tattvārthādhigama Sūtra, 5.19.
39. "Ūrdhvagāmi samiraṇaḥ Prāṇaḥ I." Adhogatirāpānaḥ I. TS. Bhā 8.12, p. 158.

In the medical science the Jaina view of the mechanics of breathing briefly outlined is fully supported in the following manners: "The respiratory apparatus consists of the larynx, trachea, bronchi, lungs and pleurae.⁴⁰ When one breathes in the air, it goes through the trachea and bronchi to the air-sacs of the lungs which are surrounded by blood capillaries. According to the property of diffusion, the oxygen inside the alveoli and the carbon dioxide in the capillaries interchange themselves through the thin membranes. As the oxygen inside the alveoli is taken up by the blood, the air inside the lungs must be renewed to bring in a fresh supply of oxygen and the waste products, such as, carbon dioxide must also be thrown out of the body".⁴¹

The first process by which one breathes in air is called inspiration, i.e. the Jaina 'apāna', and the second one by which the impure air inside the lungs is thrown out is called expiration which corresponds to the Jaina 'prāṇa'.⁴² This combined process of inhaling and exhaling air is called respiration, i.e. apāna and 'prāṇa' of Jaina Biology. The absorption of oxygen by the red corpuscles of the blood and the removal of waste products, such as, carbondioxide and water, take place in the lungs by this process of respiration.

Respiratory Devices in other Animals :

Respiration⁴² takes place in all other animals. But its detailed discussiou is not found in Jaina Biology. It can be surmised from its references that external respiration in most lower animals is carried on by specilized structures - gills, for example, of fish, molluscs, e.g. Śaṅkha (Conchifera). Śuktika (Pearl-mussel), Śambuka (Helix) and many other arthropods (spider) (Nandyāvarta, but not insects) have these organs.

According to modern Biology, "In fish, water is taken in through the mouth, passes over the gills, and out the gill clefts. Gills like lungs, have thin walls, and are moist and well supplied with blood capillaries. Oxygen dissolved in the water diffuses through the gill

40. Human Anatomy, Henry Gray, p. 1016.

41. Ibid.

42. "Urdhvagāmī samiraṇah prāṇah / adhogatirapānah prāṇah /"
T.S. II, 8.12, Tikā, p. 158

"Udasyamāṇah Koṣṭhayo vāyurucchvāsalakṣaṇah prāṇa ityucyate / Tenuyatmanā vāhyo vāvurābhyan tarikriyamāṇo nihsvāsalakṣaṇo apāṇa ityākhyāyatate /,
Sarvārthaṇḍdhi Putyapāda v. 19 p.

43. Ucchvāsapada, Paññavaṇā P. I, 7.

epithelium into the capillaries, and carbon dioxide diffuses in the reverse direction".⁴⁴

"Insects have quite a different system for getting oxygen to the cells. In each section or segment of the body is a pair of holes, called spiracles, from which a tracheal tube extends into the body, branching and rebranching until it reaches each cell".⁴⁵

"The body walls of insects pulsate, drawing air into the trachea when the body expands, forcing air out when the body contracts. Thus, in contrast to a fish or crab, in which blood is brought to the surface of the body to be aerated in a gill, the tracheal system conducts air deep within the insect body, near enough to each cell so that it can diffuse in through the wall of the tracheal tube".⁴⁶

44. Ibid.

45. Biology, p. 294.

46. Biology, p. 295.

(Third Section)

THE DIGESTIVE SYSTEM

The knowledge of food (āhāra)¹ in Jaina Biology reveals that all animals are heterotrophic² and must provide their constituent cells with a variety of raw material and sources of energy for the synthesis and maintenance of compounds present in the vital force of the body, i.e. "Carbohydrates, fats, proteins, vitamins, water and minerals"³ etc. according to modern Biology.

The analysis of the topic "Knowledge of food"⁴ of all animals, āhāraparyāpati⁵ (Vital force by which beings take, digest, absorb and transform molecules of food particles into waste products (khala) and chyle of molecules of nutrients or energy – (rasa), śariraparyāpti⁶ (vital force by which chyle or molecules of nutrients (rasibhūtamāhāraṇi) are utilized by being for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc.) throws some light upon the digestive system, metabolism and nutrition of animal organism.

The process of digestion from amoeba (Kuksikrmi, Krmi, etc.)⁷ to man (manusya)⁸ involves the same or very similar series of enzymes, but differs⁹ in where they act and the process is controlled, e.g. "Some beings, born in water, come forth as movable creatures in the water, produced by water-bodies. These beings feed on the humours of

1. Sūtrakṛtāṅga, II 3, Āhārapada.

2. Ibid.

"organisms which cannot synthesize their own food from inorganic materials and therefore must live either at the expense of autotrophs or upon decaying matter, are called heterotrophs and their mode of nutrition is called heterotrophic. All animals fungi and most bacteria are heterotrophs", Biology, P. 85.

3. Biology P. 296.

4. Sūtrakṛtāṅga II, 3. Āhārapada

5. "Tatraiśāhāraparyātisvayādāya nijocitāṁ / pṛthakkhalarasatvenāhāraṇi / pariṇātāṁ, nayet /", Loka-prakāśa, pt. I, 3rd sarga, v. 17.

6. "Tāṁ rasibhūtamāhāraṇi yayā ḡaktyā punarbhavi /"

"Rasāśṛgmānsamedo asthimājjāśukrādi dhātūtaṇi /"

Nayedya-thāsambhavāṁ sā debaparyāptirucyate //", Ibid., v. 19.

7. Sūtrakṛtāṅga, Āhārapada, II, 3. ; Pañṇavaṇā I, Āhārapada.

8. Ibid.

9. Ibid.

water-bodies, produced by water,¹⁰ where as the babies suck the mother's milk, but when they grow older, they eat boiled rice, etc.¹¹ Actually speaking, digestion is intra-cellular or extra cellular as found in Jaina Biology. According to modern Biology. "Digestion may be intracellular-food particles, may be taken into the cell by phagocytosis and digestive enzymes may act within the cell or extra cellular—the enzymes are secreted by the cells that produce them into some cavity, typically that of the gut, where hydrolytic cleavage takes place."¹² It is suggestive that two-sensed animals (i. e. protozoa) and the simpler animals take food into vacuoles within cells and digestion occurs, i. e. absorption of food and its digestion take place by the process of lomāhāra (diffusion).¹³

In the course of evolution, as it appears, the higher, more complex animals including man have developed special organs¹⁴ for obtaining and digesting food. The products of digestion, i. e. chyle (rasa) are transported by the circulatory system (rasa – haraṇīyo śirāo)¹⁵ to the cells of the body to be utilized. The digestive tract of man is essentially a long tube composed of several separate organs which carry out ingestion, digestion and absorption, such as, mouth cavity (mukha)¹⁶ tongue (Jihā),¹⁷ teeth (dāmīā),¹⁸ oesophagus, stomach (āmoru, udara)¹⁹ deudenum (pākkāśaya)²⁰ small intestine (taṇuyamīta?),²¹ liver (yakṛt)²² large intestine (Thūlamīta),²³ rectum (pāyu, gudā),²⁴ etc.

10. Sūtrakṛtāṅga II, 3. "Ihagatiyā sattā udagājōṇiyā udagāṇam siṇehamāramī /" (59) ; "te jivā dāhārā samānā māukkhirām sampīm āhāremī ānupuvveṇām rūḍhā odaṇām . . . āhāranti /" 56.
11. Ibid.
12. Biology, P. 296
13. Sūtrakṛtāṅga II, 3, (comm.) "sparsendriyeṇa ya āhārah sa lomāhāra it", p. 87.
14. Mouth (mukha), stomach (āmoru, udara), deudenum (pākkāśaya) (Kalyāṇakāraka, 3.4) small intestine (taṇuyamīta), large intestine (Thūlamīta) etc. (Tandula Veyāliya, 16, p. 35 etc.)
15. Tandula Veyāliya 16, p. 35,
16. Ibid., P. 36, (Comm.) "Mukhe aśucipārne prāyo dvātrīmīśaddantāḥ asthikbāṇḍāni bhavanti /"
17. Ibid., 16 p. 35, "Jibbhā" or "Jihā",
18. "Battisami dāmīta", Ibid.
19. "amoru", Kalyāṇakāraka 3.4. "Udara", Tandula Veyāliya, 17, p. 38.
20. "Pakkāśaya", Kalyāṇakāraka, 3.4.
21. "Taṇuyamīta", Tandula Veyāliya 16, p. 35.
22. "Yakṛt", ; Kalyāṇakāraka, 3.4.
23. "Thūlamīta" Tandula Veyāliya p. 6, p. 35.
24. "Pāyu", One of the nine śrotas (orifices), Ibid., p. 38.
"Guda", Ibid., 16, p. 36,

The Mouth Cavity (Mukha)²⁵

The mouth cavity contains the tongue, the teeth, "salivary glands,"²⁶ according to modern Biology, etc. They play role in ingestion or digestion, etc.

The Tongue (Jihā)²⁷

The tongue consists of several sets of striated muscles oriented in different places, having a length of seven fingers.²⁸ Food is pushed by the tongue between the teeth to be chewed and then shaped into a spherical mass, called bolus (Kavala)⁹ to be swallowed by the process of prakṣepāhāra.³⁰ Swallowing is initiated when the tongue pushes a bolus³¹ into pharynx.

The Teeth (Damta)³²

There are stated to be thirty two teeth of (battisam̄ damta)³³ of man. The teeth of all vertebrates break up food into smaller particles "but they vary in size and shape according to the diet of the particular animal."³⁴

Modern Biology explains that "In man, each jaw on each side has, behind the canines, two premolars and three molars, with flattened surfaces adapted for crushing and grinding food".³⁵

25. Tandula Veyāliya, 16, (Comm.) p. 36

26. Biology, p. 297.

27. Tandula Veyāliya 16, p. 35.

28. Ibid 16, p. 35

"Caupaliyā Jibbhā... sattamguliyā Jihvāmukhabhyantravartimāṁsakhaṇḍarūpā dairghyenaṭmaṅgulataḥ saptāṅgulaḥ bhavati", Ibid. (Comm.), p. 36.

29. Sūtrakṛtāṅga II. 3. (Comm.) "Kāvalika aharo Jihvendriyasya sadbhāvāditi", p. 38.

30. Prakṣepēṇa Kavalāderahāraḥ prakṣepāraḥ", Sūtrakṛtāṅya II. 3. (Comm.), p. 87.

31. "Tatra yo jihvendriyena sthūlaḥ śarīre prakṣipati sa prakṣepāraḥ", Ibid, p. 33;

32. Tandula Veyāliya 16, p. 35, Visuddhimagga gives vivid description of teeth, see Vm. XI. 51. ; VIII. 92 'Dantā hanukaṭhikesu jāta /', etc. VM. XI. 51.

33. Tandula Veyāliya, 16, p. 35 ; See also Caraka Saṁhitā IV. 7,6. ; Suśruta III. 5. 19, 20, ; A.H. II. 3.16. (Ayurvedic Saṁhitas). Kashyapa deals with the names of the teeth, such as, Rajadanta (medical incisor), Vastau (lateral incisor and canine), danṣṭre (Premolars), hanavyas (molars). K.S., 1.20, vide Sacitra Āvup-veda, March, 1972, Avika; 1, p. 78

34. Biology, p. 298.

35. Ibid.. p. 298.

The Salivary Glands :

Jaina Biology does not make mention of the salivary glands, but its reference to saliva (*lālā*)³⁶ suggests that the Jainācāryas had some idea of salivary gland which assist the food in moving down the throat, as well as to begin its chemical breakdown by secreting two kinds of saliva—"one type is watery to dissolve dry food and the other contains mucus to lubricate the food as it passes down the oesophagus and to make the food particles stick together in a bolus (*kavala*) for swallowing."³⁷

Food passes from the mouth cavity to the stomach (*āmoru* or *udara*)³⁸ through the pharynx and oesophagus as a result of peristalsis. Similar peristaltic waves help the movement of the contents of eaten food through all the organs of the digestive tube. The live airs (*Panca-Vāyus*) – *Prāna*, *apāna*, *samāna*, *Vyāna* and *udāna*, causing the peristaltic waves, help the movement of the contents of food, its ingestion, digestion and absorption, etc.³⁹

The Stomach (*Udara* or *Āmoru*)⁴⁰

The stomach is a thick-walled muscular sac on the left side of the body just beneath the lower ribs. "Soon after the food reaches the stomach, peristaltic waves begin in the pyloric region as a result of the action of air (*vāyu*),⁴¹ passing from left to right, according to Modern Biology, toward opening into the into the intestine⁴² (*āmīta*) At intervals, the pyloric sphincter relaxes, and a small amount of chyme is pushed into the small intestine by the contraction of the stomach."⁴³

36. *Aupapātika Sutra*, edited by Dr. Leumann, Leipzig, gātha. 55, (38) "Haya lalā-pelavāirege dhavau", 48.

37. Biology, p. 299.

38. *Kalyāṇakāraka*, 3.4 (*āmoru*) ; 'Udara', *Tāndula Veyāliya*, p. 38.

39. "Prāṇasthāpānasamānasamjñāu / Vyāno apyathodāna-iti pradiṣṭah pañcaiva tīvayava eva nitya – maharanjhāravirgāmārthāḥ //", *Kalyāṇakāraka*, 3.9.

40. *Tāndula Veyāliya*, 17, p. 38 ; *Kalyāṇakāraka*, 3.4.

41. *Kalyāṇakāraka*, 3.9 ; see the metabolism and nutrition discussed at the end of this section.

42. Biology p. 301.

43. Biology, p. 301.

Gastro-Intestinal Tract (Āmīta)⁴⁴

There are stated to be two intestines (āmīta) viz. small intestine (tanuyāmīta) and large intestine (thūlāmīta).⁴⁵ According to Visuddhimagga, antam starts from the oesophagus to the rectum, "like the carcase of a large beheaded rat - snake coiled up and put into a trough of blood".⁴⁶ "This bowel tube looped in twenty one places is thirty two hands (cubits) long in men and twenty eight in women. It is white in colour like the lime mixed with sand."⁴⁷

Jaina Biology states that tanuyāmīta having the length of five vāmās transforms urine,⁴⁸ while thūlāmīta having the same length transforms stool (uccāra).⁴⁹ It is difficult to identify tanuyāmīta of Jaina Biology with the small intestine of modern Biology on the basis of its function of transforming (producing) urine, for it is the function of kidney to produce urine, according to the latter. Thulāmīta can be easily identified with the large intestine of modern Biology as per its function of transforming (producing) stool out of indigestible matter carried from the small intestine. "Some water is absorbed in the small intestine" that tanuyāmīta have the function of producing of urine in addition to absorption of molecules of nutrients. But it may be identical with kidney of modern Biology on the basis of its function.

The Small Intestine (Tanuyāmīta)⁵⁰

The small intestine is a coiled tube into which the chyle passes by the force of peristalsic waves caused by air (vāhu) in the stomach (udara or āmoru). The greater part of the digestive process and almost all absorptions occur here as is suggested by the reference to "Pakkāsaya"⁵¹ (the duodenum) the first segments of the intestine-organ for cooking, i. e. digesting food with pācakaśakti⁵² (digestive power)

44. Tandula Veyāliya, 16 p. 36.

45. Ibid.

46. Visuddhimagga, XI. 64.

"Antan galavāṭakakarisaṁgappariyanta saṁrabbantare ṣhitan. Tatha, yatha lohitadonikāya obhañjītvā thapiṭe chinnasiradhamanikalevare etc."

47. "Antan ti purisassa dvattiy sahatthay, iṭṭhiyā aṭṭhavisatihāttan ekavisatiyā ṣhanesu obhaggā antavāṭṭhi etc." Visuddhimagga VIII 18.

48. "Do āmīta Pamcavāmā tatthā nām je se taṇuyāmīte Ten nām pāsavane pariṇamai" ; Tandula Veyāliya ; 16, p. 35. Kalyāṇakāraka, 3.4.

49. "Tattha nām je se thūlāmīte tēṇa uccāre pariṇamai", Ibid.

50. Tandula Veyāliya, 16. p. 3' ;

51. Tattvārthadhīgamā Sūtra 2.43 (Comm.) p. 242

52. Tandula Veyāliya 4, Kalyāṇakāraka 3.7.

According to modern Biology, the three juices (1) bile (i. e. pitta⁵³ of Jaina Biology) from the liver (yakṛt)⁵⁴ (2) Pancreatic juice from the pancreas and (3) the intestinal juice are mixed in the small intestine and complete the digestive process begun in the mouth and stomach.⁵⁵

The Liver (yakṛt)⁵⁶

Because of its contribution of the digestive juice, bile (pitta), the liver is vitally important to digestion. Visuddhimagga states that the liver (yakanaṁ) is placed near the right side between the two breasts like a twin lump of meat stuck on the side of a cooking pot⁵⁷; "it is a twin slab of muscle having brownish shed of red colour, but not too red like the backs of white water lily petals".⁵⁸

It is described in the medical science as wedge-shaped reddish brown in colour, having two lobes which are divided into four.⁵⁹ It is the largest gland in the body, occupying the entire upper part of the abdominal cavity, just below the diaphragm.⁶⁰ "In addition to its function in producing bile the liver is important in the storage and interconversions of sugars, the synthesis of plasma proteins—and a host of reactions of intermediary metabolism".⁶¹

The Absorption of Food :

Molecules of nutrients (rasa), after digestion, are absorbed into the body through the lining of the digestive tract by the āhāraparyāpti⁶² and transformed into blood, etc. by śarīra or dehaparyāpti⁶³ as suggested by the reference to the action of pañcavāyus. Modern Biology explains that "most of the absorption is done in the small intestine, particularly in the lower part of this region. Water is absorbed by the

53. Kalyāṇakāraka 3.4.

54. Biology, p. 302.

55. Kalyāṇakāraka 3.4.

56. "Yakanan anto sarire dvīṇan thanānam abbhantare dakkhiṇapassan nissāya ḥitan .. /"etc., Visuddhimagga XI. 60

57. Ibid, VIII. 114. "Yakanan ti yamakamansapaṭalan .. .etc.

58. Gray's Human Anatomy, P. 1512.

59. Biology, P. 303.

60. Ibid.

61. Lokaprakāśa I. 3.17.

62. Ibid. I. 3.19,

63. See metabolism and nutrition; Kalyāṇakāraka 3.9

colon, but almost all organic and inorganic substances are absorbed through the small intestine.”⁶⁴

The Large Intestine (Thūlamīta)⁶⁵

The material remaining, after the nutrients (rasa) have been absorbed, passes from the small intestine (taṇuyamīta) into the large intestine or colon (Thūlamīta) which is larger in diameter and with thicker walls with sixteen pañtis (walls or folds)⁶⁶ than the small intestine, according to Biology.

The main function of thūlamīta is to absorb water and reduce the wastes (Khala) to a semi-solid state (i. e. uccāra)⁶⁷ in addition to transporting the wastes to the rectum (pāyu) to be ejected from the body. In support of Jaina Biology for its function Modern Biology explains that “both churning and peristaltic movements occur in the colon, although both are ordinarily slower and more sluggish than those in the small intestine. Periodically more vigorous peristaltic movements force the contents along, until they finally reach the rectum”.⁶⁸

Comparison of Digestive System :

The Chemistry of digestion and paryāpti involved are much the same in man as in the amoeba (Kukṣi kṛmi or Krmi); the two-sensed animals (protozoa), whose bodies consist of single cells, do not of course have any digestive system, for they take food by the process of lomāhāra⁶⁹ (diffusion). So the digestion in them is inter-celullar. Modern Biology explains that “an ameba engulfs a bit of food and forms a food vacuole in which the food is surrounded by a membrane⁷⁰ (i. e. lomāhāra⁷¹ of Jaina Biology). Digestion occurs within this vacuole as it circulates in the cytoplasm. Digestive enzymes produced in the cytoplasm are poured into vacuole and digest the food within. The

64. Biology, p. 304

65. Tandula Veyāliya, 16. p. 36. Kalyāṇakārakā, 3.4.

66. Kalyāṇakāraka 3.4. Sthūtantrapāñktih śoḍaśaiva”.

67. Tandula Veyāliya ; 16, p. 35 ; “Teṇa uccāre parīṇamati”.

68. Biology, p. 305.

69. “Tayā ya phāse ya loma āhāro /”, Bṛhat Saṅgrahaṇī 183.

; “Lomāhārastu śarīraparyāptyuttarakālāṁ bāhyayā tvacā, Lomabhirāhāro lomāhārah /” Sūtrakṛtaṇga II. 3. (comm.), p. 87.

70. Biology p. 310

71. “Oyāhārajivā savve, apajjattagā muṇeyawā /

Pajjattangā ya loma, āhāro“, Pakkheve hoṇti bhaiavvā, Bṛhat Saṅgrahaṇī 182(4).

products are absorbed through the vacuole wall into the cytoplasm, where they are assimilated or used for energy".⁷²

Some of the two-sensed animals having the sense-organs of taste and touch, e. g. Nūpurakas (earth worms) take their food by the process of prakṣepāhārā⁷³ (i. e. through mouth). This Jaina view on the digestive system of earth worm as suggested by the statement of Bṛhat Saṅgrahaṇī on the process of taking food by the two-sensed animals and others is supported by modern Biology on its digestive system. To quote the same, "it has a complete digestive system with two apertures, mouth, a muscular pharynx, an esophagus, a soft walled crop where food is stored, a hard, muscular gizzard where it is ground up with the aid of small pebbles taken in with the food, along intestine when extracellular digestion and an anus through which undigested wastes pass".

As the higher animals, such as, the five-sensed vertebrate evolved, the digestive system was gradually elaborated and organs⁷⁴ added, resulting in the complex human mechanism. The digestive system of the five-sensed vertebrate from the fish to man are similar and for all animals from the lowest to the most complex, the chemistry of digestion and the āhāra paryāptis involved are much alike, as it is suggested by the process of their taking food, i. e. lomāhāra and prakṣepāhāra".⁷⁴

Metabolism and Nutrition :

Food⁷⁶ is any substance taken into the body that can be used for the release of energy, for the building and repair of tissue. After being taken into the body the molecules of food participate in a variety of chemical activities of the organism called metabolism in modern Biology. The sum of all the chemical activities of āhāraparyāpti⁷⁷ (vital force by which beings take, digest, absorb, and transform molecules of food particles) into khala (waste products) and rasa (chyle)

72. Biology, p. 310

73. "Pakkhevāhāro puṇo, Kāvaliu hoi nāyavva //", Bṛhat Saṅgrahaṇī, 183.

"Egoṇdiyadevāṇam neraiyāṇam ca natthi pakkhevo /

Sesāṇam jivāṇam saṁśaratthāṇa pakkhevo / Bṛhat Saṅgrahaṇī 185.

"Sesāṇam āhāro, lome pakkevau ceva", Ibid. 186.

74. Biology, p. 73.

75. Kalyāṇakāraka, 3.4. 5.9. Tandula Veyaliya 16, p. 36 ; 17, p. 38.

76. "Lomāhāra egimidiya ya neraiyā suragaṇā ceva / sesāṇam āhāro lome pakkevau ceva//", Bṛhat Saṅgrahaṇī 186.

77. Sūtrākṛtāṅga II. 3. (Ābārapada).

and *śarīraparyāpti*⁷⁸ (vital force by which chyle or molecules of nutrients (*rasibhūtamāhāram*) are utilized by beings for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc.,⁷⁹ which provide the energy for the growth, maintenance and repair of the organic system as well as its own growth with intensity.

The presence of the metabolic process as explained in the second section of the first chapter is one of the outstanding characteristics of living beings. After foods are absorbed from the intestine *taṇūyamīta*, they are either built into new tissue or oxidized to provide energy. Some of this energy is used in the building of new tissue, some in the function of cells and so forth. For example the foetus in the mother's womb obtains food-substance from the mother's body and transforms the same into the forms of ear, skin, bone, marrow, hair, nail,⁸¹ etc. by the metabolic process and nourishment.

Molecules of nutrients absorbed from the intestine are utilized by the organism through *śarīraparyāpti* for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc.⁸⁰

There are many ways of sub-dividing the general field of metabolism according to Jaina Biology. It is stated that there are five *vāyus* (airs) in the human body, viz. *prāṇavāyu*, *apāṇavāyu*, *samāṇavāyu*, *vyāṇavāyu* and *udāṇavāyu*. They help the ingestion, digestion, absorption and assimilation of food taken by the organism and the building of tissue and oxidation to provide energy and the excretion of the waste products (urine, faeces, etc.) from the body.⁸¹ This view of metabolism and nutrition has been elaborately explained in Āyurvedas in the following manner: The digestive tract from the mouth cavity and oesophagus to the rectum is known to be *Mahāsrota*, (the great channel). Food passes from the mouth cavity down the gullet (oesophagus) to the stomach by the action of *prāṇavāyu* (bio-motor force)⁸² (i. e.

78. *Lokaprakāśa* I, 3, 17.

79. *Bhagavatī Sūtra* 1.7.61 ; *Tandula Veyāliya* 3, p. 7.

“*Jive ḥam gabbhagae samāṇe jaṁ āhāram āhāreī taṁ ciṇāī soimdiyattāe, cakkhū-riṁdiyattāe ghāṇiṁdiyattāe jibbhīṁdiyattāe, phāsiṁdiyattāe aṭṭhiaṭṭhimimjakesa-māṁsuromanahattāe /*”

80. *Lokaprakāśa* I, 3, 19. “*Rasāśrgmāṁsa ... Śukṛādīdhātutām.*

81. *Prāṇastathāpānasamāṇasamāṇjñau / Vyāṇo, apyathodāna iti pradiṣṭah / Paṁcaiva vāyana eva nitya-māhāranihāravīnīragamārthaḥ //*” *Kalyāṇakāraka*, 3.9.

82. “*Mukhe vasati yo, anilāḥ prathila namataḥ prāṇakaḥ praveṣayati so’ annapān praveṣayate so’ annapañamakhilāmiṣāṁ sarvadā /*” *Kalyāṇakāraka*, 8.3.

a series of reflexes). There it gets mixed up first with a gelatinous mucus (phenibhūtakapham) and then it becomes acidulated by further chemical action of a digestive juice (vidāhādamīlatām gataḥ),⁸³ i. e. gastric juice, as a result of peristaltic waves in the pyloric region.

An amount of chyme is pushed by samāna vāyu (i. e. due to the contraction of stomach) into the pittāsaya by means of the grahanī-nāḍi and next into the small intestine (āmapakkāśaya).⁸⁴ There bile (pitta) converts the chyme into chyle by peristaltic contractions and churning movements.⁸⁵ The essence of chyle (sūkṣmabhāga) from the small intestine is carried through by prāṇavāyu along a Dhamanī trunk (thoracic duct?) first to the heart and thence to the liver (and the spleen).⁸⁷ In the liver the pigment (the colouring substance) in the bile acts on the essence of the chyle, especially on the tejas -substance therein, and gives it a red pigment, transforms it into blood, but the grosser part of chyle (Sthūlabhāga) runs along the Dhamanīs, being carried by the vyāna vāyu (biomotor force) all over the body⁸⁶.

After the formation of blood, the essence of the chyle in the blood, acted on by vāyu and Māṁsāgni (the flesh forming metabolic heat) forms the flesh - tissue.⁸⁷ The grosser part of the flesh - tissue thus formed proceeds to feed or replenish the flesh - tissue all over the body. The finer essence of flesh in the blood in the chyle, acted

83. “Ādau ṣadraṣasamappannaṁ madhriubhūamīrayet, phenibhūtām kaphām yātām vidāhādamīlatām gataḥ /”
Caraka-Dridhavala Saṁhita quoted by Aruṇa in his commentary on Vāgbhaṭa ; Vide Positive Sciences of the Ancient Hindus, p. 207.

84. “Samāna iti yo anilo agnisakha ucycate sarvadā /
Vasatyudara’ eva bhojanaganasya saṁpācakāḥ //” Kalyāṇakāraka, 8.5.
“Vayunā samānākhyena grahaṇīmabhīṣṭyate / ṣaṣṭhī pittadharā nāma ya kalā parikīrtitā /āmapakkāśayāntaḥsthā grahaṇī sā, abihdhiyate / agnyadhiṣṭhānamān-nasya grahaṇād grahaṇī matā /” Caraka-Dridhavalasaṁhita quoted by Aruṇa in his comm. on vāgbhaṭa ... Vide Positive Sciences of the Ancient Hindus P. 2 7.

85. “Bhuktamāṁśaye ruddhā sā vipācyā nayatyadhalī /”, Ibid., p. 207

86. “Tataḥ sārabhūtasyahārarasasya dvau bhāgau bhavataḥ / sthūlaḥ sūkṣmasca...tataḥ sūkṣmo bhāgah prāṇavāyunā prerito dhamanīmārgena ṣārīrārbhakasya raktasya sthānām yakṛt-pliharūpām gatvā tena dāha miliṭo bhavati/” Ibid, pp. 207-8.

87. “Tataḥ prāktanarakatadhaṭau eva tiṣṭhati / tataḥ sārabhūtasya ahārarasasya dvau bhāgau bhavataḥ / sthūlaḥ sūkṣmaśca sthūlo bhago rañjakākhyena pittena raktikṛṭhaḥ ṣārīrārbhakām raktām poṣayan vyānavāyunā prerito dhamanībhiḥ sañcaran sakalaśaṅgatāni rudhirāṇi Puṣṇātī /” Ibid, p. 208.
“Apāna iti yo’nila vasati bastipakkāśaye / sa vāta malamūtraśukranīkhilorugarbhārtavam”. 8.6. Kalyāṇakāraka.

on again by *vāyu* (bio-motor current) and the fat-forming metabolic heat (*medo'agni*) in the menstruum of lymph (*Kapham samāśritya*) receiving viscosity and whiteness forms the fat tissue. This fat in the chyle (or blood) or rather its grosser part replenishes the fatty tissue of the body but its finer essence in the flesh in the blood in the chyle, acted on by *vāyu* and the marrow-forming metabolic heat, in the menstruum of lymph (*Sleṣmaṇāvṛta*), becoming hard produces bone.⁸⁸ The essence of fat which fills the hollow channels of the bones gets transformed into marrow,⁹⁰ being acted on again by *vāyu* (bio-motor force) and metabolic heat. The marrow becomes similarly transformed into semen.⁹¹

It is to be observed that *rasa* (chyle) of fluid in the chyle or blood mainly acts as the menstruum throughout the metabolic process and each preceding elements of the body takes up the proper organic compounds from the food chyle to form the next element or tissue. In this process the chemical changes take place because of the metabolic heat which breaks up the compounds and recombines.

The successive formation of blood, flesh (blocks of muscle or tissue), fat, bone, marrow, semen, etc. as mentioned by Jaina Biology is fully corroborated and thus explained by the Indian Āyurvedas in details.

According to modern Biology, "there are many ways of sub-dividing the general field of metabolism, e. g. liver metabolism, carbohydrate metabolism, fat metabolism, etc. Carbohydrates, fats and proteins are the three types of fuels of the organism from which its cells obtain biologically useful energy for metabolism and nourishment"⁹².

In Jaina Biology there is a clear reference to fats (*meda, vasā*), but not to carbohydrates and proteins. Human beings can adapt to a variety of diets. So it is suggestive from the evidences of Jaina Biology that they obtain carbohydrates from sugars and starches (rice, wheat, etc.),⁹³ fats from oil, butter, clarified butter and proteins from pulses, meat, eggs, milk, etc.

88. *Tataḥ sukṣmo bhāgah vyānavayunā prerito dhamanibhiḥ śirābhiśca śarīrāmbha-kāṇi māṁsāni yāti /*, etc., Caraka, vide Positive Sciences of the Ancient Hindus p. 208.
89. *Slesmānām ca samāśritya māṁsān vāyvagnisamīyutām, sthiratām prāpya śaukal-yām ca medo dehe abhijayate /* Caraka-Dridhavala Saṁhita quoted by Aruṇa in his commentary on Vagbhat, vide Positive Sciences of the Hindus, p. 270.
90. *Pr̥thivyagnyanitādinān saṁghātaḥ śleṣmaṇāvṛtaḥ, kharatvām prakārotyasya jāyate asthi tato nṛṇām /* Ibid., P. 207.
91. "Karoti tatra sauśiryamasthānām madhye samirāṇah /," medasa tani pūryante sneho majjā tataḥ smṛtaḥ /," Ibid.
92. "Tasmānmajjñāca yah snehāḥ śukram samjāyate tataḥ /" Ibid.
93. Biology.
94. *Sūtrakṛtāṅga*, II-3.

(Fourth Section)

THE EXCRETORY SYSTEM

The normal process of cellular metabolism and the constant building up and breaking down of nutrients (rasa) by the power of paryāpti¹ result in the production of waste products (Khala), such as, mūtra² (i. e. urea, uric acid or urine, etc.) and purīṣa⁴ (faeces), etc. The (nitrogenous) waste products are useless and toxic for the body. The kidneys⁵ (taṇuyamīṭa) remove urine etc. from the blood of a normal man as rapidly as the tissues produce them.

Defecation means the elimination of wastes and undigested food collectively called faeces (uccāra or purisa) from the anus (gudā).⁷ They are not metabolic wastes (khala). Excretion refers to the removal of substances which are useless in the body from the cells and blood stream via urine and perspiration (mūtra⁸ and sveda).⁹

The excretory system of the body includes more than the kidneys and their ducts, viz. nine orifices (navasoe or navadvāras)¹⁰ : two nostrils, two ears, one mouth, one rectum and one genital,¹¹ besides eighty lakhs

1. Tatraiṣāhāraparyaptiryāyadāya nijocitaṁ /
Pṛthakkhalarasatvenāhāram parīṇatiṁ nayet //”
Lokaprakāśa, Pt. I., Sarga 3, Vol. 17.

2. Ibid.

3. “Imassa jaṇitussa saṭṭhisirāsayaṁ nābhippabhavāṇam ahogāmiṇīnām mutta-purisavayukammaṁ pavvattai /” Tandula Veyāliya, 16, P. 35, see also Kalyāṇakāraka 3.12.

4. Ibid (Purisa)

In Visuddhimagga it is called Karisaṁ (faeces) which get accumulated in rectum of large intestine (Thūlaṁṭa)—Visuddhimagga XI. 67.

5. Tandula Veyāliya 16, p. 35.

Taṇuyamīṭa transforms urine like kidneys. Its function suggests its identification with kidneys although it is to be identified with small intestine.

6. Tandula Veyāliya 16, p. 35.

7. Ibid (Pāyu, one nava śrotas), guda ; see Kalyāṇakāraka 3.12.

8. Tandula Veyāliya 16, p. 35. Kalyāṇakāraka 3.11

9. Tandula Vayāliya, p. 40 ; Kalyāṇakāraka 3.12.

10. Tandula Veyāliya, (Navasoe). 16, p. 35 ; Kalyāṇakāraka, 3.12 (Navadvāra).

11. “Navāśrotah puruṣah, tatra karṇadvaya 2-Caṭśurdvaya 2 Ghrāṇadvaya 2, mukha 7 payu 8 pastha 9 lakṣmaṇāni iti”.
Tandula Veyāliya 16 (Comm., p. 38) Kalyāṇakāraka, 3.5. 3.12.

of pores or hair follicle in the skin.¹² Women have got eleven orifices including two breasts.¹³

The function of the excretory system is to cause the elimination of carbon dioxide (apāna or niḥsvāsa)¹⁴ one of the most important metabolic wastes ; made by the lungs¹⁵ (Phopphas), of bile (pitta), the break down products of Hemoglobin, the liver (yakṛt)¹⁶ and the excretion of faeces (Puriṣa, etc. by the colon. (Thūlamīta).¹⁷

The sweat glands or pores (romakūpas)¹⁸ are "primarily" concerned with the regulations of body temperature,¹⁹ according to modern Biology but they also serve the purpose of excreting certain per cent of all metabolic wastes (as sveda).²⁰ "Sweat contains the same substances (salt, urea and other organic compounds) as urine"²¹

The kidney and its ducts :

Mention of Taṇuyamīta with its function of producing urine²² and the excretion of urine (mūtra) through the genital²³ (one of the nine orifices of the body) suggests clearly that the Jainācāryas had some knowledge of kidneys and their ducts. It is stated in the Tandula Veyāliya that Taṇuyamīta transforms (produces) urine. Some adhoga-minī śirās (ducts rising from the umbilical region) cause the excretion of urine.²⁴ In support of the Jaina view on the kidneys and their functions, Visuddhimagga explains that "kidney (Vakkamī) is situated

12. Kalyāṇakāraka, 3.5

13. "Ikkārasasoyā itthiyā" 16, p. 35.

"Pūrvoktāni nava stanadvayayuktānyekādaśa śrotāṇi strināṇi bhavanti," Ibid. (Comm.), p. 38. Tandula Veyāliya, 16, (ye se taṇuyamīta tena pāsavanta pariṇamai)

14. Tattvārthāvadhiṇī Sūtra v. 19 ; Tandula Veyāliya, 4, p. 8.

15. Tandula Veyāliya 17, p. 38.

16. Ibid, 16. 17.

17. Kalyāṇakāraka 3.4.

18. Tandula Veyāliya, 16, Kalyāṇakāraka 3.4.

19. Tandula Veyāliya 16, p. 35.

20. Biology, p. 330.

21. Kalyāṇakāraka 3.12 (Svedāṇi vamati romakūpailī)

22. "Je se taṇuyamīte teṇamī pāsavāṇe pariṇamai /" Tandula Veyāliya 16, p. 35.

23. "Navasoe", Ibid.

(U)pastha", Ibid. (Comm.), p. 38.

Dvārāṇyathātrāpi navaiva dehe /" Kalyāṇakāraka 3.5 ; 3.11 ; 3.12.

on each side of the heart muscle being fastended by the stout sinews, it develops from a single root from the base of neck and divides into two after going short way like a pair of mango fruits attached together by their stalk".²⁴ According to Antomy, this description of kindney is wrong in regard to its location, for the two kidneys are compound glands, situated at the back of the abdominal cavity, i. e. "one on each side of the spinal column and behind the peritoneal cavity. They correspond in position to the space included between the upper border of the 12th thoracic and the 3rd lumbre Vertebrae."²⁵ "The kidneys are a pair of beanshaped sttucture about 4 inchas long²⁶.

According to Visuddhimagga, "Kidney is dull red (reddish brown), like the colour of palibaddhaka (*Erythrina Indica linn*) seeds. It is shaped like a pair of child's play balls".²⁷

"The kindeys are the most important excretory organs of mammals, performing approximately 75 per cent of the work of excretion",²⁸ they have a number of other important functions as well. They regulate the concentration of various substances dissolved in the blood, maintain the balance between acids and bases and keep the blood volume constant. Since the concentration of substances in all body fluids is determined largely by their concentration in the blood, the kindneys indirectly regulate the composition of all body fluids."²⁹

Its ducts :

Jain Biology does not make direct mention of ureter connected with kidney at the upper end and with bladder at the lower end, but its reference to bladder (*vathipuḍaya*)³⁰ and the excretion of urine through (*u*)*pastha*)³¹ (urethra or genital urinal tract) throws some light upon its ducts for the excretion of urine. Visuddhimagga mentions the urinary bladder (*Vatthipuṭo*). It states that the urinary secretion

24. "Imassa jaṁtussa saṭṭhisirāsayaṁ nābhippabhaṇām ahogāmīṇām gudappaiṭ-ṭhāṇām jaṇum si nirūvaghāṇām muttapurisavāukammaṁ ḡavāttai /"
Tandula Veyāliya, 16, p. 35.
25. "Vissuddhimagga XI. 58. Vakkām galavāto nikkhantena... ṣhitān" etc.
26. VM. XI. 58.
27. Anatomy and Physiology, pp. 617-48, Dey, vide *Sacitra Āyurveda*, p. 74, March, 1972.
28. VM. VIII. 110 "Vakkan li ekabandhana dve maṇṣapiṇḍikā ... Tam vaṇṇatoman-darattan etc. /"
29. Biology, p. 330.
30. Ibid.
31. Nirayāvaliyā 1.1 ; "vatthi avānam" Pañhavāgarāṇā, 1.3, p. 58.

from the body enters the bladder which is like a porous pot without mouth put into cess pool. When the bladder is full of urine, animals feel the urge to pass urine.³²

That is to say, according to Modern Biology, "The urine, excreted by the kidney in a continuous trickle, collects in the pelvis and passes down the ureters by peristaltic waves of contraction of the ureter walls to the urinary bladder, a hollow muscular organ located in the lower, ventral part of the abdominal cavity. The muscular walls of the bladder relax and distend to make room for the urine as it accumulates. Valves at the openings of the ureters into the urinary bladder prevent the backflow of urine, and keep any bacteria that may be in the bladder from ascending to the kidney. As the volume of urine in the bladder increases, the distention of the muscular walls stimulates nerve endings located there to send impulses to the brain, producing the sensation of fullness. To make urination possible, impulses originating in the brain cause a contraction of the bladder and a relaxation of the sphincter guarding the opening from the bladder to the urethra."³³

As to the formation of urine, Jaina Biology states only that Taṇu-yamita (Kidney) transforms (or produces) urine,³⁴ but it does not throw light upon the combination of the three processes of filtration, reabsorption and augmentation which enables the kidney to remove wastes but conserve the useful components of the blood.³⁵

Excretory Devices in other Animals :

Every organism had to solve the problem of getting rid of metabolic wastes (khala). In the two - sensed protozoa, such as, Kukṣikṛmi, Kṛmi etc. the wastes (khala) seem to diffuse through the cell wall into the outside environment where the concentration is lower, as they are lomāhārins. In support of this view, modern Biology, explains that "Protozoa living in fresh water have a special problem of getting rid of water, because their protoplasm, being hypertonic to pond water, tends to absorb it continuously. To control this situation, they have

32. Tandula Veyāliya, p. 38.

33. VM. viii, 138 ; xi, 80.

"Vatthi nāma vatthipuṇo vuccati", viii. 138 "Muttaṁ vatthissa abbhantare thttam" etc. xi. 80.

34. Biology, pp. 33 -331 ;

35. Tandula Veyāliya 16, p. 35.

"Tattha nām je se tanuyaṁte teṇam pāsavaṇe pariṇamai /".

a contractile vacuole, a small vesicle in the protoplasm which empties water from the interior of the cell as fast as it is taken in".³⁶

"Earth worms have in each segment of their bodies a pair of specialized organs, called nephridia, which function in excretion".³⁷

"The excretory system of insects consists of organs called malpighian tubules. Waste products from the body cavity diffuse into these tubules and are excreted into the digestive tract, whence they are carried to the exterior with the undigested food".³⁸

The urinary systems of all the five-sensed vertebrates are essentially the same.³⁹ It is to be noted here that the child developing in the mother's womb does not pass urine or faeces,⁴⁰ as the excretory system of it is non-functional at this stage. All its waste products go the stream of the blood of the mother wherefrom they are excretory systems of the mother.⁴¹

The evolution of the urinary system is complicated by the fact that in many animals the reproductive system (U)pastha) has come to share some of the structures of the urinary system.⁴² so that several organs play, a dual role. This relationship is so close that according to modern Biology, "the two systems are frequently considered together as the urogenital system."⁴³

36. Biology, p. 331.

37. Biology, p. 335.

38. Ibid.

39. Ibid.

40. Tandula Veyāliya, 16, p. 35 ; Biology, p. 336.

41. Bhagavati Sūtra 1.7, 61-2 ; Tandula Veyāliya, 3, p. 7.

"Jivassa ḥam gabbhagayassa samāṇassa natthi uccārei vā pāsavaṇei vā, etc. /"

42. (U)pasth is the genital, one of the nine orifices through which urine is excreted.

"Dvārāṇyathātrāpi navaiva ḥehe // " Kalyāṇakāraka, 3.5.

"Mūtrāṇi saretaḥ sapuriṣaraktāṇi sravatyad hastādvivaradvaye ca", Ibid. 3.11.

43. Biology, p. 336.

(Fifth Section)

THE INTEGUMENTARY AND SKELETAL SYSTEM

The integumentary (*camma*) and skeletal (*atṭhiya*) systems function independently of each other. The skin¹ which covers the body, and the bony frame (*atṭhiya*)² which supports it, are both organ systems, groups of organs that act together to perform one of the primary life functions. They act as protective devices for the body and together with the muscles they determine the shape and the symmetry of the body.³

The Skin (*Camma*)⁴

All multicellular animals are covered externally by a skin or integument.⁵ The skin is one of the important organ systems and performs many diverse functions, according to modern Biology, "such as, (1) it protects the body against a variety of external environment, (2) it shields the underlying cells from mechanic injuries caused by pressure, friction or blows, (3) it protects the body against disease-producing organisms, (4) it protects the body with its water-proof quality from excessive loss of moisture or the excessive intake of water in the case of aquatic animals, (5) it affords protection to the underlying cells from the harmful ultra-violet rays of the sun, (6) it can produce suntan by virtue of the pigment."⁶

"The skin also functions as a thermostatically controlled radiator, regulating the elimination of heat from the body, ... approximately 90

1. Tandula Veyāliya, P. 41. "Māṁsacammalevāṁmi."
2. "Aṭṭhiyakaḍhiṇe "Tandula Veyāliya, P. 41. Tiṇṇi Āṭṭhidāmassayāim", Tandula Veyāliya, 16, p. 35, p. 41. "Aṭṭhi" Ibid 6, p. 10.
3. Aṭṭhiyakaḍhine siranhārubaṁdhaṇe māṁsacammalevāṁmi /, Tandula Veyāliya, p. 41
"Aṭṭhiyathāṇāḍharie, Pae, nārubaṁdhaṇibaddhe /
tayamaṁsavasāchannammi, īṁdiā'ārakkhaguttāmi //", Saṁvegarāṁgaśālā, Sūtra. 1860, p. 146,
4. Tandula Veyāliya, 3, p. 7. ; Bhagavatī Sūtra 1.7.61.
5. "Māṁsacammalevāṁmi", Tandula Veyāliya, p. 41.
"Bāhiṁ tu tāe Veḍhi athire /" Saṁvegarāṁgaśālā, Sūtra 1860, p. 146.
"Aṭṭhiyakaḍhiṇe siranhārubaṁdhaṇe māṁsacammalevāṁmi /"
Tandula Veyāliya, p. 41. Visuddhimagga explains that whole body is covered with skin like a big lute covered with damp oxhide" VM XI. 5!. "Tacū sakala sarīram pariyonāḍhītvā thito..yathā allagocāmma pariyonaddhaya etc."
6. Biology, p. 337.

percent of the total heat passes through the skin. The evaporation of sweat from the surface of the skin lowers the body temperature by removing from the body the heat necessary to convert liquid into water vapour".⁷ According to Jaina Biology, the skin contains number of different sense-receptors (*sparśānendriyas* = senses of touch) which are responsible for man's ability to feel pressure (*guru*) temperature, (*tāpā*) and pain (*asāta-vedanā*) and to discriminate the objects touched - cold (*sīta*) or warm (*uṣṇa*), rough (*rūkṣma*) and smooth (*snigdha*),⁸ etc.

The Jainacaryas mention 9900000⁹ or 8000000¹⁰ *romakūpas* (hair-follicles) in the skin of the body without hairs and beards, and 35000000¹¹ *romakūpas* (hair follicles) having hairs. That is to say, "there are specialized glands located in the skin for giving off a great amount of perspiration, getting rid of the necessary heat from the body to convert the liquid sweat into water vapour, etc."¹²

This view of Jaina Biology is supported to some extent by modern Biology which explains that "specialized glands are located in the skin. Some 2 1/2 million sweat glands occur all over the body, but are most numerous on the palms of the hands, the soles of the feet, in the arm pits and in the forehead; oils glands, too, are found all over the body, but are especially numerous on the face and scalp. They secrete film of oil to keep the hair moist and pliable and to prevent the skin from drying and cracking."¹³

Parts of the Skin :

According to Jaina Biology, there are seven parts (or layers) of skin.¹⁴ While modern Biology states that skin is composed of two main parts: a comparatively thin, outer layer, the epidermis, free of blood vessels, and an inner, thicker layer, the dermis, packed with

7. *Ibid.*, p. 338.

8. *Tatra sparśo' aśāvidhāḥ* : *Kaṭhinomūḍurgururlaghu śītauṣṇāḥ snigdho rūkṣma iti // Tattvārihādhigama Sūtra*, 5.23, *Bhaṣya*, p. 356.

9. *Navanauīm ca romakūvasayashassaiṁ nivattei 9900000 viṇā kesamāṁsuṇā saha Kesamamsuṇā addhuṭṭhāo romakūvakodjo nivattei "35000000"* *Tandula Veyāliya*, 2, p. 6.

10. *Lakṣaṇyaśīṭīca hi romakūpā /*, *Kalyāṇakāraka*, 3.5

11. *Tandula Veyāliya* 2, p. 6,

12. *Biology*, p. 338

13. *Biology*, p. 338.

14. "Tvac eva sapta", *Kalyāṇakāraka*, 3.4, p. 31.

blood vessels and nerve ending,"¹⁵ Visuddhimagga describes that the outer side is called the outer cuticle (germinative zone of the epidermis) which is black, brown or yellow in colour; "the skin itself is white and its whiteness becomes evident when the outer cuticle is destroyed by contact with the flame of a fire or the impact of a blow and so on."¹⁶

As to the shape of the skin, Jaina Biology states that it has different¹⁷ (ṇāṇā samīthāṇā), while Visuddhimagga¹⁸ describes that it is of the shape of the body in brief. But the skin covering phalanges (Padāṅgulitaco) is of the shape of silk-worms cocoons, the skin covering metatarsal bones is that of shoes with uppers, the skin covering calf of fibula bone is like a palm leaf wrapping cooked rice) the skin covering the femur is of the shape of a long sack full of paddy, the skin covering the hip bone (buttock) has the shape of hide stretched over a plank, the skin of the belly is of the shape of the hide stretched over a guiver, the skin of the backs of the hand (radius) is like the shape of a razor box, or the shape of the comb, the covering phalanges and metatarsal bones is of the shape of a key box; the skin of the face resembles the shape of an insect's nest full of holes and the skin of the cranium is of the shape of a bowel bag.¹⁹ Buddhist description of the skin has been made in detail on the basis of the shapes of individual parts of the body which are covered by the skin.

Mention of seven layers of skin in Jaina Biology is supported by modern Biology in some respects when the latter describes that "the epidermis is really made up of several of different kinds of cells, which vary in number in different parts of the body".²⁰

"The dermis is much thicker than the epidermis and is composed largely of connective tissue fibers and cells".²¹

15. Biology, p. 338.

16. Visuddhimagga VIII, 93, vide Sacitra Āyurveda, p. 67. Vīvāyurveda-aṇka, March, 1972.

"Tassa upāri kālasāmāpitādivaṇṇā chavi nāma, Taco pana vaṇṇato seto ye va. So C'assa setabhāvo aggijālābhīghāta-, aharāṇa hārādihi viddhansitāya chaviyā pākato hoti santhānato sarirasanthāno va hoti /"

17. "Nāṇāsāmīthāṇasamthie paṇṇatti /", Paṇṇavaṇā, 15, Samīthāṇadārāṁ,

18. "Taco ti śakalasariram vethetva thita camman.. santhānato sarjrasaṇṭhāno va hoti /", Visuddhimagga VIII, 93

19. "Viṭṭhārota pana, Pādaṅgulitaco Kosakāraka-Kosasāṇṭhāno . sīsattaco pattattha vikasaṇṭhāno iti /".

20. Biology 338.

21. Ibid.

The reference in Jaina Biology to the covering of the body (or skeleton) with skin, fat and muscles suggests that "the epidermis with several layers is the portion which is tanned to make leather and below this and connected with the underlying muscles is a layer composed of many fat cells and a more loosely woven network of fibers.²⁴ This part of the dermis is one of the principal depots of body fat.

"This fat helps prevent excessive loss of heat and acts as cushion against mechanical injury. The dermis is richly supplied with blood and lymph vessels, nerves, sense-organs, sweat glands, oil glands and hair follicles.²⁵

Outgrowths of the Skin :

The hair²⁶ and nails²⁷ of man, the feathers²⁸ of birds, scales²⁹ of fish, snake, etc., claws³⁰ of some animals, hoofs³¹ and horns³² of other Vertebrates are actually derivatives of the skin. The entire skin, except the palms of the hands and soles of the feet, is equipped with lakhs of hair follicles³³-in-pocketing of cells (romakūpas) from the inner layer of the epidermis.

22. Sarīvegaraṅgaśālā Sūtra 1860, p. 146. Bāhīm tu tāe Vēḍhie atthire /"
"Aṭṭhiyakaḍhiṇe siranhārubaṇḍhane māṁsacammalevam mi /",
Tandula Veyāliya p. 41.

23. Biology. p. 338.

24. Ibid.

25. Biology, p. 338.

26. Bhagavati Sūtra, 1.7.61 ; Tandula Veyāliya, 2, p. 6.

27. Ibid.

28. Tattvārthādhigama Sūtra II. 34 (Comm.) "Pakṣīṇāṁ ca lomapakṣāṇāṁ";
"Lomapradhānāḥ pakṣā yeṣāṁ te lomapakṣāḥ" Ibid., (Tikā).

29. Matsya (fish), sarpa (snake), etc. as mentioned in Jaina Biology. have got scales.

30. Saṇapphadā animals have got claws, such as śīṁha (lion), Vyāghra (tiger), etc. Paṇṇavaṇā Sutta I, 74.

31. The hoofed animals have hoofs ; they are ekakṣurā (soliduṇḍigular animals), e. g. horse ; dvikṣurā (biungular animals) e. g. cow see Paṇṇavaṇā Sūtra, 1. 71-72.

32. Cows and deer have horns.

33. It is stated in the Tandula Veyāliya (2, p. 6,) that there are 35,000,000 romakūpas (hair follicles) with hairs and 9900000 (hair follicles without hairs. "Navanauim ca romakūvasayasaḥassāim nivatteti viṇā kesamamsuṇā saha Kesamamsuṇā addhuṭṭhāo romakūvakodio, nivatteti /"
Tandula Veyāliya, 2, p. 6. That is, except the palms of the hands and soles of the feet, the entire skin is equipped with lakhs of hair follicles-inpocketings of cells from the inner layer of the epidermis.

According to modern Biology, "these cells undergo division and give rise to the hair cells, just as the inner layer of the epidermis gives rise to the outer layers. But the hair cells die, while still in the follicle, and the hair visible above the surface of the skin consists of tightly packed masses of their remains. Hair grows from the bottom of the follicle, not from the tip".³⁴

There are stated to be twenty nails including all finger nails and toe nails.³⁵ They also "develop from the inpocketings of cells from the inner layer of the epidermis and the growth of nails is similar to that of hair".³⁶

It is suggestive from the statement in Jaina Biology that "sweat flows through the hair follicle"³⁷ that "oil and sweat glands are derived from the inner layer of the epidermis by inpocketings which go deep into the dermis. Each hair follicle is associated with oil glands".³⁸

Head Hair (Keśas)³⁹ :

Head hairs are called Keśas which grow on the inner skin (reticular layer of the dermis) of scale of cranium. Visuddhimagga states that they grow on the reticular layer of the dermis of scalp of cranium (sisakaṭāhapaliveṭhanacamme jātā), just as kuntha grasses grow on the top of ant-hill.⁴⁰

As to location, of (hair follicle) it is the wet inner skin (dermis) that envelops the skull, "it is bounded on both sides by the root of the ears, in front by the forehead and behind by the napkin. As to delimitation, they are bounded below by the surface of their own roots which are fixed by entering to the amount of the tip of a rice grain into the inner skin that envelops the head."⁴¹

34. Biology, p. 339.

35. "Samkhyā nakhānāmapi viriṣatiḥ syat /". Kalyāṇakāraka, 3.6, p. 31.

36. Biology, p. 339.

37. "Svedam Vamatyutkaṭaromakūpair /" Kalyāṇakāraka, 3.12 ; p. 32.

38. Biology, p. 339.

39. Bhagavati Sūtra 1.7.61, ; Tandula Veyaliya 2, p. 6 ; p. 7

40. VM XI 48. "Ime Kesā nāma sisakaṭāhapalivethanacamme jātā ?" "Kesā tāva ... Pacchato Galavātā... ... Paricchinnanā... ... okāsa / Paricchedato kesā heṭṭhā attano mūlatalena.. paricchinā /" "Sāta"

41. Ibid. VIII. 83.

Body Hair (Loma)⁴² :

Body hairs are called romas in Jaina Biology, they grow on the inner skin. Visuddhimagga also states that “the inner skin envelops the body (sariraveṭhanacamme jāṭā) just as dabbha grasses (Desmostachya bipinnava staff) grow on the square in a lonely village”.⁴³ Body hairs are not pure like heap hairs but blackish brown (Kālapingalā); they resemble calm roots with the tips bent down, they lie in the two directions, they are found on nearly every part of the surface of the body, but are absent from the palms of the hand and sole of the feet⁴⁴ as (they) are indicated in Jaina Biology,⁴⁵

According to modern anatomy,⁴⁶ ‘the dorsal surface of distal phalanges, the umblicus, the glans penis, the inner surface of the prepuce and inner surface of labia majora and minora are free from lomas (body hairs)’.

Visuddhimagga states that hair roots are embedded in the skin to the extent of likha”.⁴⁷

Nails (Nakhas)⁴⁸

Nails (nakhas), as mentioned in Jaina Biology, are anatomically speaking, appendages of the skin (stratum corneum of epidermis) and composed of clear horny cells of the epidermis.⁴⁹ In support of this contention, Visuddhimagga states that nails grow on the tips of the fingers and toes (dorsal surface of the terminal phalanges) just as children play a game by piercing madhuka fruit (Bassia, latifolia) kernel with sticks,⁵⁰

42. Bhagavatī Sūtra 1.7.61. Tandula Veyāliya 2, p. 6; p. 7.

43. VM. XI 49. “Lomā sariraveṭhanacamme jāṭā Tāṭhā, yathā suññagāmaṭṭhām jāṭesu dabbatiṇakesu../”,

44. VM. VIII 93. ‘Tattha loma tāva .. Kālapingalā .. hatthapādatalāni ca yebhny-yena avasesasariraveṭhnacamme jāṭā etc. “

45. Tandula Veyāliya, 2, p. 6.

46. Gray's Anatomy, p. 1347.

47. VM. VII 90. “Pariccededato sariraveṭhana camme likhāmattan pavisitvā patiṭṭhitena, etc,”

48. Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya, 2, p. 6 ; 3. p. 7.

49. Anatomy and Physiology, pp. 674, 676. Dey.

50. VM. XI, 50. “Nakha aṅgulinan aggesu jāṭā. Tattha, yatha, Kumārakesu dāṇḍakeh madhukāṭṭhike vijjhītī vīkālantesu na dāṇḍakā jānanti /”

The Skeleton (Aṭṭhiya),⁵¹

The first and most obvious function of the skeleton is to give support and shape to the body. In order that an animal may rise off the ground, some hard, durable substance is needed to maintain the soft tissues against the pull of gravity and act as a firm base for the attachment of muscles. These requirements are met by the bones.⁵²

The skeleton also protects⁵³ the delicate underlying organs, such as, the brain (matthu), lungs (phopphasaphephasa),⁵⁴ etc. from injury. The marrow tissue (aṭṭhimimjā)⁵⁵ within the cavity of the bones "performs", according to modern Biology, the special tasks of manufacturing all red corpuscles and same kinds of white ones.⁵⁶

The Skeleton (Aṭṭhiya).⁵⁷

According to Jaina Biology, the human skeleton system consists of three hundred pieces of bones⁵⁸ and one hundred and sixty joints.⁵⁹ It is not composed solely of bones; but its connective tissue fibers (māṁsapeśis)⁶⁰ and tendons (māṁsarajju)⁶¹ are important in helping to maintain body form by holding the organs together. Two specialized kinds of connective tissue fibers, ligaments⁶² and tendons⁶³ (Kamdarā) (māṁsarajju) attach bones to bones and muscles to bones, respectively, thereby playing an indispensable role in locomotion.

Types of Skeletons :

The skeleton of an animal may be located on the outside of the body (an exoskeleton) or inside the body (an endoskeleton). The hard

51. Tandula Veyāliya p. 41. "Aṭṭhiyakaḍhina"
52. "Aṭṭhiyāñṭhīñādarie, pae ṇhārūbandhaññibaddhe / tayamāṁsavaśāchannamī, īmīā / ārakkhaguttamī" Saṁvegaraṁgasālā, Sūtra, 1860, p. 146.
"Aṭṭhiyakaḍhine sirañhārubañdhame māṁsacammalevamī /"
Tandula Veyāliya, p. 41,
53. Saṁvegaraṁgasālā, Sūtra 1860 p. 146
54. Tandula Veyāliya 17, p. 38
55. Ibid 6, p. 10
56. Biology, p. 339.
57. Tandula Veyāliya, p. 41.
"Aṭṭhiyakaḍhiṇe". "Aṭṭhiya is a term for both a single bone and a frame work of bones. See, Visuddhimagga VI. 10.
58. "Tiṇṇi aṭṭhidāmasayām" Tandula Veyāliya, 16, p. 36.
59. Saṭṭhi saṁdhisayām". Ibid. ; Kalyāṇakāraka mention 300 Joints, 3.2.
60. Tandula Veyāliya, 2, p. 6., 16, p. 36.
61. Kalyāṇakāraka, 3.4, p. 31.
62. "Kandarā (?)" Kalyāṇakāraka, 3.3.
63. Māṁsarajjam, Ibid. 3.4

shells of Śaṅkha (conchifera), Suktika (pearl mussel) and Śambuka (Helix),⁶⁴ etc. are examples of exoskeleton. Man and all the other five-sensed vertebrates characteristically have endoskeleton.⁶⁵ As mentioned, the human skeleton consists of three hundred bones.⁶⁶ There is a divergence of views among the Indian sciences of Biology on the total number of bones of the human body. Caraka⁶⁷ mentions three hundred and sixty bones including teeth and their alveolii, Suśruta⁶⁸ enumerates three hundred bones like Jaina Biology. Visuddhimaggā⁶⁹ shares this view in this matter, while Vāgbhaṭ⁷⁰ supports Caraka in his contention. But modern Biology⁷¹ states that the human skeleton consists of approximately two hundred or two hundred and six⁷² bones. "The exact number varies at different periods of life, as some of the bones which at first are distinct gradually become fused⁷³". Most of the bones are hollow and contain the bone marrow (aṭṭhimimjā).⁷⁴

Parts of the Skeleton :

The five-sensed Vertebrate human skeleton as found in Jaina Biology may be divided into the axial skeleton (the bones and cartilages in the middle or axis of the body),⁷⁵ and the appendicular skeleton (the bones and cartilages of limbs).⁷⁶ The axial skeleton includes the skull (śirām),⁷⁷ backbone (piṭṭhakaramdā),⁷⁸ ribs (pāṁsaliyārūvakaramdā)⁷⁹ and breast bone (sternum = Kaḍāha).⁸⁰

64. Tattvārthādhigama Sūtra, II, 24.
65. Tandula Veyāliya, 16, p. 35; p. 41 (Aṭṭhiyakaḍbīne).
66. "Tiṇṇi" aṭṭhidāmasayāim", Tandula Veyāliya, 16, p. 35.
67. Carakasāṁhita IV. 7.6
68. Śuśruta Saṁhitta III. 5.50. "Evamasthām triṇi ḡatāni pūryante /"
69. Visuuddhimaggā VI. 89 "atirekatisata aṭṭhikasamamussayan"
70. A. H. II. 3 16.
71. Biology, p. 339.
72. Vide Sacitra Ayurveda, p. 69, March, 1972.
73. Biology, p. 339.
74. Bhagavatī Sūtra 1.7.61. ; Tandula Veyāliya., p. 3, p. 7; 6, p. 10.
"aṭṭhiṭṭhāmimjakesa.....etc.,
75. Tandula Veyāliya, 16, p. 35.
76. Ibid 17, p. 38 ; p. 41.
77. Tandula Veyāliya 16, p. 35.
"Caukavālaṁ śirām" "Caturbhi kapālaiḥ-asthikhaṇḍarūpaiḥ śiro bhavati (Comm.)
Ibid.
78. Āṭṭhārassa ya piṭṭhakaramdakya -prsthī Vamśasya sandhayo granthirūpā bhavabts
yathā vamśasya parvani, teṣu (comm).
79. "Barasa pamsaliya karamda" Ibid.
Sarire dvādasa (Pamsulkaripah Karāndakahvamsaka bhavati (comm)).
80. Chappamsuttie Ibid 16. See its comm. kadahe.

The skull (*siram*)⁸¹ is made up of a number of bones fused together ; the cranium or bony case (*siroghaḍi*) immediately around the brain (*Matthu*),⁸² and the bones of the face (*mukham*)⁸³.

The backbone (*Piṭṭhakaramda*) including *grivā* (neck)⁸⁵ is made of separate vertebrae⁸⁶ in different points along the spine. Different vertebrae (*Karamḍaga*)⁸⁷ have different projections for the attachment of ribs (*pamṣaliya*) and for articulating (joining)⁸⁸ with neighbouring vertebrae.

The rib basket⁸⁹ is composed of a series of flat bones which support the chest wall and keep it from collapsing “as the diaphragm contracts”.⁹⁰ The ribs are attached dorsally to the vertebrae, each pair of ribs being attached to a separate vertebra⁹¹ of the twelve pairs⁹² of ribs in man, the (first) six are attached ventrally to the breast bone,⁹³ the rest are attached indirectly by cartilages without having attachments to the breast bone.⁹⁴

The bones of the appendages or arms (*bāhu*)⁹⁵ and legs (*urujāṅghā*)⁹⁶

81. “Caukavālam *siram*”, Tandula Veyāliya 16, p. 35.
 “Cauturbhiḥ kāpālaḥ-asthikhaṇḍarūpah śiro bhavanti ? Ibid., Comm., p. 36,
 “*sariram* sisaghaḍi”, Tandula Veyāliya 17, p. 38.

82. Imam ca *sariram* sisaghaḍi “*Matthu*”.
 Ibid “Sirṣa ghaṇīva mastakahḍām-medāṣca-asthikṛt etc. (comm.) Ibid ; p. 38

83. Tandula Veyāliya p. 40

84. Tandula Veyāliya 16, p. 35.

85. *Grivā* consists of 7 Vertebrae, having the length of 4 fingers. According to Tandula Veyāliya, there are 16 bones of neck – solasa givāṭṭhiya muṇeyavvā”, Ibid, p. 41.

86. Aṭṭharaśa ya piṭṭhakaramḍaga-Ibid 16, p. 35,

87. “Bārasa *pamṣaliya*”, – Ibid.

88. “aṇupuvvēṇam karamda” aṭṭhārassa ya piṭṭhakaramdaśamdhīo”, Ibid.

89. Bārasa *pamṣaliya* karamḍā chappaṁsulie Kaḍāhe bihatthiyā Kucchi /”, Ibid.

90. Biology, p. 340.

91. Saṁdhiyo anupuvvēṇam aṭṭhārassa ya piṭṭhakaramdaśamdhīo-here bārasa *pamṣaliya* karamda chappaṁsulie kaḍāhe. Tandula Veyāliya. 16

92. “Bārasa *Pamṣaliyā*”, Ibid.

93. “Chappaṁsulie kaḍāhe”, Ibid.

94. “Bārasa *Pamṣaliyā* Karamḍā”, Ibid.

95. “Aṁsalagabāhulaga aṁguli” Tandula Veyāliya, 17. p. 38.

96. “Urujāṇujāṅghāpāya”, Ibid.

and the girdles⁹⁷ (*kađi*) which attach them to the rest of the body, make up the appendicular skeleton.

The pelvic girdle⁹⁸ consists of three fused hip bones, and the pectoral gridle⁹⁹ consists of the two collar bones, or clavicles, and two shoulder blades (*amśalaga*) or scapulas. The pelvic girdle is securely fused to the vertebral column¹⁰⁰ whereas the pectoral girdle is loosely and flexibly attached to it by means of muscles.

The appendages of man are comparatively primitive, terminating in five digits - the fingers¹⁰¹ and toes.¹⁰²

The bones of the arm¹⁰³ are the humerus of the upper arm, the radius and ulna of the lower arm, the eight tiny carpals of the wrist, the five slender metacarpals of the palm, and the fourteen phalanges, or finger bones¹⁰⁴ two in the thumb¹⁰⁵ and three in each finger. The leg bones are the femur in the thigh, the tibia and fibula in the shank,¹⁰⁷ the seven tarsals in the ankle, the five metatarsals across the instep and the fourteen phalanges in the toes. The great toe has only two phalanges, every other toe having three. The patella or knee cap¹⁰⁸ is a separate bone of the leg; there is no counterpart for it in the arm^{108a}.

The Joints (*Sandhi*):

The joint (*sandhi*)¹⁰⁹ is the point of junction between two bones, such as, those between the bones of the skull (*siram*),¹¹⁰ the

97. "Kadi", Tandula Veyaliya, p. 41. "Amsalagabahulaga... ... sandhi saṁghāya-saṁdhiyamīnam" Ibid, 17 ; "Urujānuśaṁghāpāyasaṁdhiyam" Ibid, 17.
"Jāmūha ḫihiyāsu ūru pāi ḫihiyā taṭhiyā Kadipīṭṭhī" Ibid p. 41

98. "Kadipīṭṭhī / Kadiyā ḫivedhiyāim aṭṭharasa piṭṭiahiṇi Tāndula-Veyaliya, p. 41.

99. "Aṁsalaga-aṁsayoḥ-skandhayoḥ, etc." Ibid (Comm.). p. 39.

100. Taṭhiya Kadipīṭṭhī Kadiyā ḫivedhiyāim aṭṭharasa piṭṭihaṭṭhī", Ibid, p. 41.

101. "Aṅguli-aṅguṭṭha", Tandula Veyaliya 17, p. 38.
"Piṭṭhakarāṁdaga", Ibid., p. 16. p. 35.

102. Ibid, 17, p. 38.

103. Biology, p. 341

104. "Bāhulaga-aṅguli", etc. Ibid., 17, p. 38.

105. "Aṅguthega" Ibid.

106. "Uru", "Jāmghā ḫihiyāsu ūru pāi ḫihiyā", Ibid., p. 41.

107. "Jāmghā", Ibid, p. 41

108. Jānu, Ibid, 17. p. 38.

108a Biology, p. 341

109. "Saṭṭhi saṁdhisayaṁ", Tandula Veyaliya, 16, p. 35 ; Ibid. 17, p. 38.

110. "Caukāvalām siram," Ibid. 16, p. 35 ; Sisaghāḍi, Ibid, p. 38.
; "Aṣṭhikhandarūpaīḥ śiro bhavati", Ibid. (comm.) p. 36.

articulation of the humerus to the scapula¹¹¹ or the femur¹¹² to the hip bone,^{112a} etc.

As pointed out, according to Jaina Biology, there are stated to be one hundred sixty joints (sandhis).¹¹⁴ Visuddhimagga mentions one hundred and eighty joints, while Suśruta¹¹⁵ refers to two hundred and ten joints. Jaina Biology speaks of some major joints like Visuddhimagga,¹¹⁶ such as, shoulder joints,¹¹⁷ arm-joints,¹¹⁸ and nail joints,¹¹⁹ etc.

Types of Locomotion :

The Jaina classification of animals into egakhurā (Solidungular), dukhurā (Biungular), Gaṇḍipadā, (Multiungular) and Saṇapphadā (animals having toes with nails, such as, lions, tigers, etc.)¹²⁰ reveals that animals differ as to the part of the foot they put on the ground in walking and running. Man walks flat on the palm of the foot "a type of locomotion adapted by bear also."¹²¹ It may be called "Plantigrade."¹²² Some animals, such as, dogs (Suṇagā) and cats (Viḍāla), i.e. Saṇapphadā, have became adapted to running on their digits, "a type of locomotion called digitigrade."¹²⁴ Some animals, such as, horses and deer (assa and miya),¹²⁵ i.e. hoofed animals egakhurā and dukhurā, walk and run upon the tips of one or two digits of each limb, "a type of locomotion called "unguligrade."¹²⁶

111. Aṁśalagabāhulaga ...saṁdhisaṁghāyasamdhīyamīnam', Ibid., 17, p. 38.

112. "Uru.....saṁghāyasamdhīyamīnam", Ibid., Jaṁghaṭṭhi ṫrupaiṭṭhiya

112a "Tatthiyā Kaḍipiṭṭhi" Ibid., p. 41.

113. Ibid., 16, p. 35; "Imāṁmi sarīre saṭṭhi ṣamdhīsayaṁ".

114. VM. VI. 45.

115. Suśruta III. 5.6.

116. VM. VI. 45 mentions 14 major joints – shoulder joints 2, elbow joints-2, wrist joints-2, hip-joints, 2, Knee-joints two, ankle joints – 2, Crancovertebral joint-1 sacro-iliac joint 1.

117. "Aṁśalaga bāhulaga aṁguli aṁguliṭṭhagaṇhāsa ṣamdhīsayaṁ /" Tandula Veyāliya, 17, p. 38.

120. Paṇṇavanā, 1.70

121. Biology, p. 343

122. Ibid. p. 343

123. Paṇṇavanā, 1-70, 74.

124. Biology, p. 343

125. Paṇṇavanā, 1. 71-72.

126. Biology. p. 343

Besides one hundred sixty joints, Jaina Biology mentions six Samīnahaṇas (Samīghayaṇa) (firm joints or firmness of joints) viz. (1) Vajra – ḥṣabha – Nārāca – Samīhanana, (2) Rṣabhanārāca – samīhanana (3) Narāca Samīhanana, (4) Ardhanārāca – Samīhananā, (5) Kilikaśamīhanana and (6) Sevārta (or chedapṛṣṭhā) Samīhanana.¹²⁷

The first one is an excellent joining of the gross body. The two bones are hooked into each other ; through the joining a tack (vajra) is hammered and the whole is surrounded by a bandage. The second is not so firm a joining as the preceding one, because the bandage is missing. The fourth one is a joining which is on the one side like the preceding one, whilst on the other the bones are simply pressed together and nailed. The fifth one is a weak joining by which the bones are merely pressed together and nailed. The sixth one is quite a weak joining, by which the ends of the bones only touch one another.¹²⁸

127. Vide Lokaprakāśa, 3-399, p. 132.

“Vajjarisahonārāyam paṭṭhamām biyam ca rishanārāyam Nārāyamaddhanārāyakiliyā tahaya chevaṭṭham/” ; Karmagrantha I. 38-40.

128. Lokaprakāśa I. 3, 400-405.

“Sa mīghayaṇamāṭṭhīnicayo, tam chaddhā vajjarisahanārāyam
Tahaya risahanārāyam, nārāyam addhanārāyam (38)
Kiliya chevaṭṭham iha risaho. pattolya vajjam
Ubhao makkadabāṁdhao, nārāyam imamuralainge //” (39) Karmagrantha I.

(Sixth Section)

THE MUSCULAR SYSTEM

In man (*manuṣya*) and most animals the ability to move depends upon a group of specialized, contractile cells, the muscle fibers. Man and most five-sensed vertebrates are quite muscular animals. Almost half of the mass of the human body consists of muscle tissues (*māṁsapeśi*).¹ According to Jaina Biology, there are stated to be five hundred muscle-tissues or (blocks of muscle) of man, four hundred and seventy of woman, and four hundred and eighty of enuch (neuter belonging to the third sex).²

Visudhimagga mentions nine hundred muscles in the human body³ which plaster over the frame work of bones like a well plastered with thick clay,⁴ while the Suśruta⁵ refers to five hundred muscles like Jaina Biology. Visuddhimagga further states "muscle lies in both directions (origin and insertion) and it is plastered over the three hundred and odd bones and is bounded below by its surface which is fixed on to the collection of bones above by the skin all round each by each other."⁶

According to this work, the shape of the muscles of the calves (*fibulae*) is like that of cooked rice in a palm-leaf bag, that of the muscle of femur (*quadriceps femoris*) is like that of a rolling pin (*nisdadaota*), that of the muscle of the buttock (*gluteus maximus*) is like that of the end of an even, that of the muscles of the back (*trapezius* and *Latissimus dorsi*) is like the shape of slab of palm sugar, that of the muscle between each two ribs (*Serratus anterior* or *Intercostalis Internus*) like that of clay mortar squeezed thin in a flattened opening, that of the muscle of the breast (*Pectoralis major*) is like that of a lump of a clay made into ball and flung down, and that of the

1. Tandula Veyāliya, 2, p. 6 ; 16, p. 36. ; Kalyāṇakāraka, 3.2, p. 30.
"Pañca pesisayāim purisassa,.....etc."
2. "Pañca pesisayāim purisassa tisūnāim
itthiyāe visuṇāiṁ paṁḍagassa /" (16), Tandula Veyāliya 16, p. 35.
3. VM. XI 53 (navapesi-satappabhedena māṁsena litto ti)
4. Ibid. (yatha mahāmattikālittāya bhittā yā na bhitti, jānāti).
5. Suśruta III, 5.6, "Pañca pesisatāni /".
6. VM. VIII. 97, 98, vide sacitra Āyurveda, p. 68. March, 1972.
"Māṁsam ti nava māṁsapesisatāni... 97;" V.M.
; Disato dvisu jātam lokāsato sādhikāni tiṇi atthisatāni anulimpitvā ṣhitām
paricchedato heṭṭhā aṭṭhisāṅghāte patiṭṭhitatalena, upari tacena...etc." (98) VM.

muscle of arm bone (Biceps and triceps brachii) is like the shape of a large skinned rat and twice the size.⁷

Mention of 500 muscles of man, 470 muscles of woman and 480 muscles of the neuter in Jaina Biology suggests that in the Vertebrates three types of muscles have evolved to perform various kinds of movements. (1) skeletal muscle, which is attached to and moves the bones of the skeleton, (2) cardiac muscle which enables the heart (hiyaya) to move and moves the blood through the circulatory system (śirā, dhamāni and srota) and (3) smooth muscle, which makes up the walls of the digestive tract and certain other internal organs, and moves material through the internal hollow organs.

The Muscles of Lower Animals.

The muscles of all animals from the flat worm to man are similar in that they are all made of long cylindrical or spindle-shaped fibers "which are contractible because of the protein chains."⁸ Most of the invertebrates (two to four-sensed animals) have only smooth muscle ; whereas arthropods (gaṇḍūpada=knotty-legged and Nandyāvarta=spiders, Arthropoda, etc.) have only striated muscle.

7. Ibid. (97)

"Sanīhanato jaṅghapinḍikamāṁsaṁ tālapaṇṇaputabhattasāṁthānam Ūrumāṁsaṁ nisadapotasāṁthānam / Ānisadamaṁsaṁ – uddhanakośisanthānam / piṭṭhimāṁsaṁ tālagulapatalasāṁthānampāsakadvayamaṁsaṁ koṭṭhalikāya kucchiyām tanumatikalepasāṁthānāṁtibanaṁsaṁ vāṭjevta avakkhittmātikāpiṇḍasāṁthiānam . pakaṭam hoti" (97).

"Disato dvisu disāsu jātam. Okāsato sādhibhāni tiṇi aṭṭhisatāni anulimpitvā ṣhitām . etc.", Ibid, 93.

8. Biology, p. 350.

(Seventh Section)

THE NERVOUS SYSTEM

The nervous system is a complex co-ordinating device to keep the various parts of anything as complicated as the human body functioning. It integrates the activities of all the parts of the body. The nervous system (*ṇāhru*)¹ is composed of brain (*matthu*),² spinal cord (*pitthakaramḍā* ?)³ and nerve trunks (*anegaṇhāru*),⁴ it connects receptors (eyes, ears, nose, tongue and skin) with effectors (muscles and glands) and conducts impulses from the one to the other. The two mains functions are conduction and integration.

According to Jain Biology, there are stated to be nine hundred *ṇhārūs* (nerves),⁵ sixteen ligaments (*kamdasās* ?)⁶ to bind two pieces of bones at the joints, two tendons for every muscle (*dve māṁsarajju*)⁷ to attach itself to pieces of bones with the two tapered ends.

Visuddhimagga explains that the “ligaments are found in the anterior of the body binding the bones together as withies and sticks are bound together with creepers”.⁸

A like Jaina Biology both Visuddhimagga^{8a} and the Suśruta⁹ *samhitā* mention nine hundred nerves (*navasnāyuśatāni*).

The Nerve Impulse :

The study of the nature of the nerve impulse in Jaina Biology is fraught with difficulties because nothing visible occurs when an impulse passes along a nerve. But its reference to the process of sense-perception that “the ear hears the touched and entered sounds, the

1. Tardula Veyāliya 16, p. 35.

2. Ibid, 17. p. 38.

3. Ibid 16, p. 36.

4. Ibid, 17, p. 38.

5. “*Nava ṣhārūṣayāim*” Tardula Veyāliya 16, “*ṣṇāyunāṁ asthibandhanaśirāṇāṁ navaśatāni*,” (Ibid., comm.), p. 37.

6. Kalyāṇakāraka 3.3., p. 30. “*Ṣoḍaśa Kāṁdarāṇi*”, Ibid 3.4, p. 31.

7. “*Dve māṁsarajju*”, Ibid, 3.4, p. 31.

8. Visuddhimagga XI 54

“*Nhārū sārīrabhantare aṭṭhiniābandhā mānā ṣhitā, tatthayāṭhā vallīhi-vinaddhesu kuḍḍadāruśu, etc.*” Sacitra Āyurved, p. 68, March 1-72.

8a Visuddhimagga VIII 99. (*Nhārū ti nava ṣhārū-satāni*)

9. “*Suśruta* III. 5.6. “*Nava snayuśatāni*”, p. 479.

eye sees the non-touched and non-entered sense-objects, the nose smells the touched and entered smells, the tongue tastes the touched and entered objects in the mouth and the skin experiences the touches of the touched and entered objects”,¹⁰ suggests that the nerve system, composed of brain, spinal cord and nerve trunks, connects receptors, (muscles and glands) and conducts the impulses from one to the other in such a way that when a given receptor is stimulated the proper effector responds appropriately. That is to say, in the words of modern Biology” the impulses transmitted by all types of neurons—motor, sensory and connector—are essentially alike. The fact that one impulse results in sensation of sight, another in a sensation of sound, and another in muscle contraction, and another in glandular secretion, is due entirely to the nature of the structures to which the impulses themselves”.¹¹

The Central Nervous Systems :

The nine hundred nerve cords¹² that make up the nervous system in Jaina Biology may be divided into two main parts : those belonging to the central nervous system which make up the brain (matthu)¹³ and spinal cord (piṭṭhakaramdā?)¹⁴ and those belonging to the peripheral nervous system, which make up the cranial and spinal nerves.¹⁵

The Spinal Cord (Piṭṭhakaramdā?)¹⁶

It is the tubular spinal cord, surrounded and protected by the neural arches of the vertebrae, it has two important functions: “to transmit impulses to and from the brain and to act as a reflex centre”,¹⁷ according to modern Biology.

10. Bhagavatī Sūtra, 2.4.99.

“Prajñāpanā Sūtra Indriyapada, Puṭṭhadāram, 15. 1-194-195

“Puṭṭhāim saddāim suneti... . . .

Pavīṭṭhāim saddāim suneti tahā paviṭṭhānivi”.

Panṇavanā, puttadāram 15. 194-195

11. Biology, p. 356.

12. Tandula Veyāliya, 16, p. 35.

13. Ibid 17, p. 38.

14. Ibid 16, p. 36.

15. “Etto nāqiddāram, nāqī ca tihā bhāqāmī tavviuṇo / padqhamā iqā parā piṅgalā ya taiyā susūmaṇā ya (3123)”, Saṁvega Ramgasālā, p. 243. edited by Shāh
“Idā ca piṅgalā caiva suṣumṇā ceti nāqikān /”

61, Yogaśāstra, Hemacandra, p. 347.

16. Tandula Veyāliya, 16, p. 35.

17. Biology, p. 360.

The Brain (Matthu)¹⁸

It is the enlarged, anterior end of the spinal cord. "In man the enlargement is so great that much of the resemblance to the spinal cord is obscured, but in the lower animals the relationship of brain to cord is clear."¹⁹ The brain contains brain matter (matthulūmga).²⁰ The detailed anatomy of the brain which is exceedingly complex is not given in Jaina Biology. According to modern Biology, there are six main regions, medulla, pons, cerebellum, midbrain, thalamus and cerebrum."²¹

The Peripheral Nervous System

The paired cranial (sirañhāru)²² and spinal nerves, emerging from the brain and spinal cord and conducting with every receptor and defector in the body make up the peripheral nervous system. (Idā, piñgalā, suṣumṇā)²³

Cranial Nerves (Sirañhāru)²⁴

Cranial nerves originate in different parts of the brain (matthu) and innervate primarily the sense-organs, muscles and glands of the head. It appears from the reference to the sense-perceptions caused by the nerve impulse through the activities of the five sense-organs (eye, ear, nose, tongue and skin)²⁵ that some of the 900 nerves act as cranial nerves so that they innervate primarily the sense-organs of eye, ear, nose, tongue and skin muscles and glands of the head. As a result one impulse results in a sensation of sight, another in a sensation of sound, another in a sensation of smell, another in a sensation of taste, another in a sensation of touch, another in muscle contraction of the head²⁶ and so on—all due entirely to the nature of the structures to which the impulses travel, as suggested by the different structures of the five sense-organs and their modes of function.²⁶

18. Tandula Veyāliya, 17, p. 38.

19. Biology, p. 361.

20. Tandula Veyāliya, 17, p. 38.

21. Biology, p. 361.

22. Tandula Veyāliya, p. 41.

22a Sañvegarāṅgasala 3123; Yogaśāstra 61, Hemacandra,

23. Biology, p. 366.

24. Tandula Veyāliya, p. 41.

25. Prajñāpanā Sūtra, Indriyapada Puññhadara, 15, 1. 194.5.

26. Ibid.

According to modern Biology, "twelve pairs of nerves originate in different parts of the brain and innervate primarily the sense-organs, muscles and glands of the head. The same twelve pairs, innervating similar structures, are found in all the higher vertebrates—reptiles, birds and mammals, fish and amphibia have only the first ten. Like all nerves these are composed of neurons, some have only sensory neurons, some are composed almost completely of motor neurons and others are made up of both sensory and motor neurons."²⁷

As explained in the Suśruta, the cranial nerves are as follows : "(1) Four pairs of sensory nerves carrying sensory impulses from the sense-organs to the heart, viz. the optic, auditory, olfactory and gustatory nerves,²⁸ and (2) six pairs of motor or mixed nerves, e. g. three pairs of motor nerves for the eye (Motores oculorum, Pathetic and Abducentes) working on the levator palpebrae and other muscles of the orbit ; one pair of motor nerves for articulation (the Hypoglossal) ; one pair of motor nerves for the larynx the pneumogastric), and another pair connected with mammae and (in the case of the male) the seminal duct".²⁹ "Other motor or sensori-motor impulses are carried by some of these cranial nerves, viz. these which produce sighs and sobs, yawning, laughter, and hunger. Evidently some of the functions of the pneumogastric and the spinal accessory nerves are intended, as also phrenic and other nerves of the cervical plexus".

Spinal Nerves :

All spinal nerves are mixed nerves, having motor and sensory components in roughly equal amounts, as they are suggested by the reference in Jaina Biology to Idā, Suśumṇā and Piṅgalā nāḍīs³⁰ along the spinal cord. The Suśumṇā is the central cord in the vertebral column,

26a Pañṇavaṇā 15, Indriyapada, Saṁthānādāraṁ Puṭhadāraṁ and Pāvīṭhadāraṁ, etc.
27. Biology, p. 366.

28. Ürddhvāgāḥśabḍārūparasagandhapraśvāsochvāsavijyāmbhitakṣuddhasitakathitarudītādiṇviśeṣān abhivahautāḥ śārīraṁ dhārayanti tā stu hṛdayamabhipratipannāṣṭridhā Jāyante tāstriṁśat tāṣāntu vātapiṭṭakaphaśonitarasān dve dve vahastāṣṭa-
daṣā / śabḍarūparasagandhān aṣṭābhīrgṛhṇite dvābhyaṁ bhasate, dvābhyaṁ
ghoṣam..karoti/dvābhyaṁ svapiti /dvābhyaṁ pratibudhyate/dve ca aṣṭuvāhinyau /
dve stanasaṁśrīte / te eva śukraṁ karasya stanābhyaṁ abhivahataḥ //"
Here Dhāmanīs act as nerves. Suśruta, Śārīrasthāna. Chap. IX.

29. The Positive Science of the Ancient Hindus, p. 218.

30. "Etto nāḍiddāraṁ, nāḍī ca tihā bhānaṁti tavyiuṇo.
Paḍhamā idā parā piṅgalā yā taiyā
Suśumṇā ya (3123)", Saṁvega Raṁgasālā, p. 243 "see Yogasāstra of Hemacandra
"Idā ca piṅgalā caiva suśumṇā ceto nāḍikah(61)

i.e. it is in the central channel of the spinal cord. The two chains of the sympathetic ganglia on the left and the right are named *Idā* and *Pingalā* respectively³¹. *Idā*, the left sympathetic chain, lies stretching from under the left nostril to below the left kidney, in the form of a bent bow, while the *pingalā* is the corresponding chain on the right.³²

According to *Saṅgītā-ratnākara*,³³ “of the seven hundred nerve-cords of the sympathetic-spinal system the following fourteen are most important, viz. (1) *Suṣumnā*, in the central channal cord,

?1. “*Vāmavahā āillā, dāhinaparivāhīnī bhave biya*

Taiyā puṇā ubhayavahā..... (3124)”, *Saṅvega Rāmāgasālā* ; p. 243

“*Vāmagā idā nāḍī ḡaṇīṇāḥ sthānamā dākṣīṇāgā pingalā nāmā rāvēḥ sthānamā madhyamagā suṣumnā nāmā sivasthānamā (61)*”

Yogaśāstra, *Hemacandra* ; p. 347

32. *Ibid.*

33. *Saṅgītāratnākara*, *Svarādhīyāya*, *Piṇḍotapatti-prakaraṇam* *Slōkas* 151–163.

“*Tāseba bhūritarāstāsu mukhyāḥ proktāścaturdaśā / Suṣumṇedā piṇgalā ca kuhūrātha sarasvatī (151)*

Gāndhārī hastījihvā ca vāruṇī ca yaśavini / Viśvadarā saṅkhīnī ca tatah pūṣā payavini (152).

Alambuseti tatrādyāstisro mukhyatāmā matāḥ / Suṣumṇā tīṣṭu śreṣṭha vaiśnavī muktiṁārgagā (153).

Kāmādāhyē sthītā tasyā idā savye ‘atha dākṣīne / Piṇgaledāpiṇgalayoścaratās candraḥaskarau (154).

Kramātikalāgaterhetu suṣumnā kālaśoṣī / Sarasvatī kuhūscāste suṣumṇāyāśtu pārśvayoh (155).

Idāyāḥ Pr̄ṣṭhapūrvasthe gāndhārīhastījihvīke / Kramātpūṣāyaśasvinyau pingalā-pṛṣṭha pūrvayoh (156).

Viśvadarā madhyadeśe syātkuhūhastījihvayoh / Madhye kuhūyaśasvinyorvāruṇī saṁsthītā matā (157).

Pūṣārasvatīmadhyamadhyamadhiṣete payavini / Gāndhārikasarasvatyormadhye vasati ḡaukhīnī (158).

Alambusā kāmādāhyē tatrēdāpiṇgale kramāt / Savyadakṣīṇāśāntām Kuhūrāmehanām purah (159).

Sarīsvatyurdhvamājihvam gāndhāryā pṛṣṭhataḥ sthītā / Āvāmanetramāsavyapādāṅguṣṭhām tu samsthītā (160).

Hastījihvā sarvagā tu varuṇyatha yaśavini / Āsaṅguṣṭhādakṣīṇāṅgadhrīstā dene viśvadarā’ākhilam (161).

Saṅkhīnī savyaakarṇāntām pūṣā tvā yāmyanetrātah / Payavini the vitata dākṣīṇāśravaṇāvadhi (162).

Alamvusā pāyueṁūlamavaṣṭabhyā vyavasthītā.

Evamvidhe tu dehe’ asminnmalasāṁcayasāṁvṛte “163”.

Saṅgītā-ratnākara 151–163 pp. 59–61. Sāraṅgadeva.

(2) *Iḍā*, the left sympathetic chain stretching from under the left nostril to below the left kidney, in the form of a bent bow. (3) *Piṅgalā*, the corresponding chain on the right, (4) *Kuhu*, the pudic nerve of the sacral plexus, to the left of the spinal cord, (5) *Gāndhārī*, to the back of the left sympathetic chain, supposed to stretch from below the corner of the left eye to the left leg, (6) *Hastijihvā* to the front of the left sympathetic chain, stretching from below the corner of the left eye to the great toe of the left foot. (7) *Sarasvatī* to the right of *Suṣumnā*, stretching up to the tongue (the hypo-glossal nerves of the cervical plexus), (8) *Puṣā*, to the back of the right sympathetic chain, stretching from below the corner of the right eye to the abdomen (a connected chain of cervical and lumbar nerves). (9) *Payasvinī*, between *Puṣā* and *Sarasvatī*, auricular branch of the cervical plexus on the right, (10) *Saṅkhini*, between *Gāndhārī* and *Sarasvatī*, auricular branch of the cervical plexus on the left, (11) *Jaśasvinī*, to the front of the right sympathetic chain, stretching from the right thumb to the right leg (the radial nerve of the brachial plexus continued on to certain branches of the great sciatic), (12) *Vāraṇā*, the nerves of the sacral plexus, between *Kuhu* and *Jaśasvinī* ramifying over the lower trunk and limbs, (13) *Viśvadarā*, the nerves of the lumbar plexus, between *Kuhu* and *Hastijihvā*, ramifying over the lower trunk and limbs, and (14) *Alambuṣā*, the coccygeal, nerves proceeding from the sacral vertebrae to the urinogenital organs".³⁴

Modern Biology explains that "All the spinal nerves are mixed nerves, having motor and sensory components in roughly equal amounts. In man they originate from the spinal cord in thirty one symmetrical pairs, each of which innervates the receptors and effectors of one region of the body. Each nerve emerges from the spinal cord as two strands or root which unite shortly to form the spinal nerve. All the sensory neurons enter the cord through the dorsal root and all motor fibers leave the cord through the ventral root.

The size of each nerve is related to the size of the body area it innervates, the largest in man is one of the pairs supplying the legs. Each spinal nerve, shortly beyond the junction of the dorsal and ventral root, divides into three branches: the dorsal branch, serving the skin and muscles of the back; the ventral branch, serving the skin and muscles of the sides and belly; and the autonomic branch, serving the viscera".³⁵

34. The Positive Sciences of the Ancient Hindus, p. 228 see *Sangita ratnakara, Svarādhyaṭa, Piṇḍotpattiprakaraṇam-s'lokas 151 - 161*, pp. 59-61.

35. Biology, pp. 366-7.

The autonomic nervous system³⁶ consists of a special set of peripheral nerves which innervate the heart, lungs, digestive tract and other internal organs. This system in turn is composed of two parts, (1) the sympathetic and (2) parasympathetic nerves. The autonomic system contains only motor nerves, and is distinguished from the rest of the nervous system by several features. The sympathetic system³⁷ consists of nerve-fibers whose bodies are located in the lateral portions of the gray matter of the spinal cord. The parasympathetic system³⁸ consists of fibers originating in the brain and emerging via the third, seventh, ninth and especially the tenth or vagus nerves, and of fibers originating in the pelvic region of the spinal cord and emerging by way of the spinal nerves in that region".³⁹

36. *Ibid.* p. 369

37. *Ibid.*

38. *Ibid.*

39. *Ibid*

(Eight Section)

THE SENSE-ORGANS (INDRIYAS)¹

The body of two-sensed animals-kṛmis (worms), Kukṣikṛmis (amoeba) and other single - celled animals is sensitive to touch and taste (sparśa and rasa)² as evidenced by the fact that it will move away from bright lights, etc. But on a higher, more complex level of existence, where the activities of searching for food, attracting a mate, etc., e.g. of five - sensed animals, are correspondingly more complex and hazardous, the animal needs specialized cells sensitive to one or a few types of stimuli, to help him in his struggle for life.³ As found in Jaina Biology, such receptors (sense-organs) in the evolutionary process have been developed, they are called indriyas (sense-organs).⁴ The receptors in these organs are remarkably sensitive to the appropriate stimulus ; the eye (cakṣu) is stimulated by an extremely faint beam of light, whereas a strong light is required to stimulate the optic nerve directly, as it is suggested by the statement that the eye sees the non-touched and non-entered objects⁵ (i. e. an image of objects is reflected when a strong light stimulates the optic nerve directly).

All beings from the earth quadrates and two-sensed worms (Kṛmis) to man (manuṣya) have sense-organs (indriya) in the evolutionary process varying in numbers from one to five (ekendriya-pañcendriya)⁶ to help them in their struggle for life. Beings have been classified by Jaina Biology on the basis of the number of their sense-organs (indriyas) into one-sensed up to five-sensed animals (Pañcendriyas)⁷.

1. Pañnavāṇā, Indriyapadañ “Pancendriyāṇi”, T.S., 2.15.
2. “Beīndiyāṇam.. do īndiyā pañnattā tamjahā – Jibhiñdie ya phāśimdie ya /, Pañnavāṇā 15 Indriyapadañ, 987 ; Tattvārthādhigama Sūtra, 2.7.24. p. 174
“Kṛmyadīnām . pṛihivyādibhya ekena vīḍche sparśanarasanendriye bhavataḥ /”
3. tato apyekena vīḍdhāni pipilikā – rohṇikā prabhītīnām trīṇi sparśana rasana – ghrāṇāni / tato, apyekena Vīḍdhāni bhramara pataṅgādīnām catvāri sparśana-rasana-grhāṇā-cakṣūmīśā/ceṣṭānām ca tiryagyonyijāṇām matsya... ... manusyadevānām pañcendriyanīti //” TS. Bhāṣya II. 24, p. 174.
4. “Pañca īndiya pañnattā, tamjahā soīndie 1 Cakkhiñdie 2 ghāṇimdie 3 Jibhiñdie 4 phāśimdie” 5. Pañnavāṇā, Indriyapada 15-973, p. 288.
“Sparsanarasanaghṛāṇacakṣūḥsrotraṇi, T.S., 2-20, p. 169.
5. ‘Apuṭṭhāim rūvāīm pasati” Pañnavāṇā 15, Indriyapada, Puṭṭhadāvām, 990, 2.
6. Pañnavāṇā 15, Indriyapada, 985-987, 241-243 “Vāyvantānāmekam” TS., II. 23, p. 172 “Kṛmiipilikābhramaramanuṣā dināmekaikaवीḍdhāni” TS. II. 2-24, p. 163 ; T.S. 2-23.
- 7 Ibid

Traditionally men have five-sensed organs,⁸ viz. organs of touch, taste, smell, sight and hearing,⁹ but it is misleading for some of the five can be divided into several completely different senses. Thus, touch, (sparśa) can be divided into eight kinds, viz cold (śīta) and heat (uṣṇa) and others¹⁰ which are all included under the sense of touch (sparśanendriya).

According to modern Biology, "In addition there are more vague and generalized, but nevertheless important senses for determining internal states of the body. The receptors for such senses are located in the Viscera, the throat, and other places."¹¹

"Stimulation of one sense-organ, e. g. skin, initiates what might be considered" a coded message", transmitted by the nerve fibers and decoded in the brain. How the sense-organ initiates different codes and how the brain analyzes and interprets them to produce various sensations are still unknown,"¹²

The Stimulus Receiving Process ;

For all types of sense-organs¹³ the actual excitation of the sensitive cell is either mechanical or chemical. The stimulation of touch (sparśa) and pressure receptors is (i. e. sense-organs of touch) or the skin (sparśanendriya) depends on the mechanical stresses transmitted through the surrounding capsules as it is suggested by the statement in Jaina Biology that the skin experiences the sensation of touch of the touched and entered objects.¹⁵

That is to say "the proprioceptors (kinesthetic receptors) respond to the mechanical pressure exerted on them when the surrounding muscle cells or tender fibers are stretched or compressed."¹⁶

8. "Mānuṣya devānām pāñcendriyāṇī" Ibid II 24, Bhāṣya, p. 174

9. Ibid ; Pañṇavaṇā, I, dīriyapadaṁ 15.

10. "Tatra sparso aśāvidhah kaṭhino mṛdurgururlaghuḥ śīta uṣṇah etc., i i", TS. V. 23, Bhāṣya, 355 see also TS., II. 23, 24.

11. Biology, p. 273.

12. Biology, p. 374.

13. Pañṇavaṇā, 15, Indriyapadaṁ

14. Ibid, Puṭṭhapāram.

15. (Puṭṭhāim) ...evam r̥aśānavi phaśānavi /", Pañṇavaṇā, Putthādāraṁ, Indriyapada, 900, 4, p. 243

16. Biology, p. 374.

The sensitive cells in the organs of hearing (śravaṇendriya) and balance are excited by the ripples or waves in the fluids bathing them as implied by the reference in Jaina Biology to the statement that the organ of hearing hears the touched and entered sounds into it.¹⁷

In contrast, the olfactory cells of the nose (ghrāṇendriya) and the taste buds of the tongue (Jibbhendriya) are stimulated chemically by the molecules that come in contact with them, as suggested by the fact that the tongue tastes the touched and entered objects into the mouth,¹⁸ while the nose smells the touched and entered fine particles of matter into it.¹⁹ The receptors for heat (uṣṇa) and cold (śīta) respond to chemical changes induced in them by changes of temperature as implied by the suggestion that śīta (cold) and uṣṇa (heat or hot) are two of the eight touches inherent in matter (pudgala). The statement "the eye sees the non-entered objects"²⁰ implies that the images of objects perceived by the eye are reflected on the retina of the eye. That is to say, "the cells of the retina respond to the chemical reactions that occur when light falls on them".²¹

The Perception of Sensations :

After the stimulus receiving process through the five sense-organs, there follows the perception of sensations. Jaina Biology describes the perception of sensations in its own manner ; e. g. different kinds of touch (spārṣa), taste (rasa), smell (gandha) and colour (varṇa).²² It is suggestive from this fact that "the qualitative differentiation of stimuli depends on the sense-organ itself and brain, for man's ability to discriminate red from cold is due to the fact that particular sense-organs and their individual sensitive cells are connected to particular parts of the brain"²³ and only those nerve impulses that reach the brain can result in sensations.²⁴

17. Paññavaṇā, Indriyapada, 15, Puṭṭhadāraṁ, 99.)
Puṭṭhāīṁ saddāīṁ suṇei, no apuṭṭhāīṁ saddāīṁ suṇei.
18. "Puṭṭhāīṁ (rasāīṁ) evāī rasāṇavi,
Paññavaṇā Sutta, 15, Indriyapadām, Puṭṭhadāraṁ, p. 213
19. "Puṭṭhāīṁ gaṇḍhāīṁ agghāī /" Ibid.
20. 'Apuṭṭhāīṁ rūvāīṁ pasātī /", Ibid.
21. Biology, p. 374.
22. "Tatra sparśo aśāvidhah - kāṭhino mṛḍurgururlaghuhī śīta uṣṇah snigdho rukṣma iti / rasa pañcavidhah tiktah kāṭuh kāṣāye, amlo madhu iti / gandhō dvividhah - surabhisurabhiṣca / varṇah pañcavidhah krṣṇo nilo lohitah pītah śukla iti //"; Tattvārthādhigama Sūtra, Bhaṣya V. 23, p. 356.
23. Biology, p. 374.
24. Ibid.

The Tactile Senses (Sparśanendriya)

The skin contains several different types of simple sense-organs, as they are indicated by the eight kinds of touch of matter²⁵ and their further divisions as felt by the skin when it comes into contact with them. According to modern Biology, "each muscle, tendon and joint is equipped with nerve endings, called proprioceptors, which resemble certain sense-organs of the skin." These are sensitive to changes in the tension of the muscle or tendon and initiate impulses to the brain which are responsible for our awareness of the position and movement of the various parts of the body, the sense referred to as kinesthesia.²⁶

The Chemical Senses of Taste and Smell :

The statement in Jaina Biology that the tongue tastes the touched and entered objects in the mouth and the nose smells the touched and entered particles of attenuated matter²⁷ suggests that "the sensation of taste and smell result from the stimulation of chemoreceptor cells in the tongue, and nose respectively by specific substances"²⁸. The tongue taste the material objects which come into contact with it and the nose smells the thing when it comes into contact with the former.²⁹ How is it possible ? Modern Biology explains that "embedded in the mucous membrances of the tougue and soft palate are special sense-organs known as taste buds, each of which consists of a few sensitive cells surrounded by supporting cells."³⁰ In Jain Biology it is stated that there are five basic taste-sensations. viz. tikta (bitter), kaṭu (pungent) kaṣāya (astringent), amla (sour) and madhura (sweet),³¹ each due to a different kind of taste bud as explained by modern Biology. "The buds are distributed unevenly over the surface of the tougue so that certain parts are especially sensitive to sweet things, others to sour things, and so on".³²

The flavour of a substance depends only partly on the sense of taste (rasanendriya), according to Biology, "the rest is due to the

25. Tattvarthādhigama Sūtra, Bhāṣya V. 23, p. 356.

26. Biology, p. 375

27. Paññavāṇa Sutta, 15, Indriyapadam, Puṭṭhadaram, p. 243.

28. Biology, p. 376

29. Paññavāṇa 15, Indriyapadam, puṭṭhadāram, p. 243.

30. Biology, p. 376.

31. Tattvarthādhigama sūtra, V. 23 (Bhāṣya)

32. Biology, p. 376

sense of smell, substances pass from the mouth through the internal nares into the nasal chamber and stimulate the sense-organs there. When one has a cold, foods are relatively tasteless because the sense of smell is partly or wholly lost".³³

The statement in Jaina Biology that the sense-organ of smell (ghrāṇendriya) smells the particles entering the nostrils and touching their sensitive cells³⁴ implies the suggestion that "the sense-organs of smell are located in the epithelial lining of the upper part of the nasal cavity in a region not ordinarily washed by the incoming air".³⁵ Particles entering the nostrils reach them by diffusion and dissolve in the mucus covering the sensitive cells".³⁴

In contrast to the sensation of taste (rasa) the various odours (gandha) cannot be classified into definite types except into two categories: surabhi gandha and asurabhi gandha (pleasant and unpleasant),³⁷ for each substance has its own distinctive smell. "The olfactory organs respond to remarkably small amounts of a substance".³⁸

Vision of Eye :

According to Jaina Biology, only the four-sensed and five-sensed animals have the vision of eye.³⁹ But modern Biology states that the light sensitive cells exist in almost all living matter."⁴⁰ It should be noted here that all animals have five bhāvendriyas including cakṣurīndriya,⁴¹

33. "Biology, p. 376.

34. Pañṇavaṇā Sutta, Indriyapadām Pūṭhadārām.

35. Biology, 377.

36. Ibid.

37. "Gandho dvividhah – Surabhirasurabhiśca /".
Tattvārthādhigama Sūtra V. 23, Bhāṣya, 356.

38. Biology, p. 377

39. "Tato' apyekena vīddhāni bhramara – vaṭarasāraṇgmakṣikā – puttikā – daṁśa – maṅga – kavīcika – nandyavartakīta – pataṅgādīnām catvāri sparśana – rasana – ghrāṇa – cakṣumi /" TS. II 24, Bhāṣya.

"Śeṣāṇām ca tiryagyoni-jānām matsyoraga-bhujaṅgapakṣi-catuṣpadānām sarveṣām ca nāraka-maṇuṣyadevānām pañcendriyāṇīti," Tattvārthādhigama Sūtra, II 24, Bhāṣya. 3. 174 Pañṇavaṇā 1.15 (Indriyapada), p. 253 11.1028

"Caurīṁdiyānām ...do ḡettā 2 do ghāṇā 4 Jihā 5 phase 6" Sesāṇam jahā nerajyāṇām (sū '0'6) jāva vēmāṇjyāṇām / Ibid 11. 1029, p. 253

40. Biology, p. 377

41. Through Bhāvendriya all-beings may be sensitive to light, as all beings have five bhāvendriyas. "Pañca bhāvīṁdiyā soīṁdie iāva phāsīṁdie" Pañṇavaṇā, 12.1056 "evāṁ jassa jati imdiya tassa tattīya bhāṇiyavvā' jāva vēmāṇiyanām /" Pañṇavaṇā 1.15, p. 259. ; see also TS. II-16, p. 163.4 (Bhāṣya).

"Even protazoa respond to changes in light intensity, usually moving away from the source of light."⁴² Most plants orient their leaves and flowers toward the sun,⁴³ although they have no special light sensitive structures. In most of the higher animals (particularly four-sensed and five-sensed animals) this light-sensitivity is located in certain cells and is highly developed.⁴⁴ The human eye⁴⁵ is an excellent example of an extremely sensitive specialized organ for perceiving light.

Some two-sensed protazoa "have "eye spots" which are more sensitive to light than the rest of the cell."⁴⁶

The eyes of insect (three-sensed and four-sensed animals) are "mosai" eyes, quite different from the camera eyes of vertebrates. "Mosaic eyes are composed of many, sometimes thousands of visual units, each with a small bundle of light sensitive cells and a fixed, immovable lens. Such an eye does not give a single, sharp picture but produces a mosaic to which each unit of the eye contributes a separate image."²⁷

The Human Eye :

The human eye is like a lens⁵⁰ or "a de luxe leica loaded with extremely sensitive colour films"⁴⁹ It sees the reflected objects on the retina as it is suggested by the statement that 'the eyes see the non-touched and non-entered objects.'

"The analogy between the human eye, and camera is complete. The eye has a lens which can be focussed for different distances, a diaphragm (the iris) which regulates the size of the light opening (the pupil) and a light sensitive retina located at the rear of the eye, corresponding to the film of the Camera. Next to the retina is a sheet of cells, filled with black pigment which absorbs extra light and prevents internally reflected light from blurring the image (Cameras are also painted black on the inside). This sheet, called the choroid also contains the blood vessels which nourish the retina."⁵⁰

42. Biology, p. 377.

43. "Tathā padmādinām prātaurikas naṁ /" Śāddarśana Samuccaya, Guṇarāṇa, Jainamatam, V. 49 (Tikā), p. 158.

44. TS. 2. .3; Biology, p. 377.

45. Ibid Pāṇṇavaṇā I. 15, Indriyapada, paṭṭhadāra.

46. Biology, p. 377

47. Biology, p. 377 Bees, etc. have mosaic eyes.

48. Māsuracāndasāñthāṇasāṁhie pāṇṇatte /"

48a. Pāṇṇavaṇā, paṭṭhadāraṁ. Pāṇṇavaṇā, 1.15, 974, p. 238.

49. Biology, p. 377.

50. Biology, p. 377. Pāṇṇavaṇā, 18. Indriyapada, paṭṭhadara.

The Ear (Srotendriya) :

As described in Jaina Biology, the ear is of the shape of Kadamba Puṣpa⁵¹ (Kadama flower). It is suggestive from the statement “the ear hears the touched and entered sound”⁵² that the organs of two different senses, hearing and equilibrium, are located in the ear.⁵³ According to modern Biology, “these organs are buried deep in the bone of the skull, and a number of accessory structures are needed to transmit sound waves from the outside to the deep lying sensory cells.⁵⁴

INDRIYAS (SENSE – ORGANS)

Conclusion :

Indriyas have been studied in Indian Philosophy from the points of view of etymology of the word ‘Indriya, cause of indriyas, their place, (subtraction), their number, their object, their shape, their mutual identicality and difference, their kinds and distinction of apprehensibility of substance – quality (dravyaguṇagrahitvaviveka, etc.) The earliest reference to its etymology is come across in the Pāṇini Sūtra.⁵⁵ The same etymology of the word ‘Indriya’ found its way in the early Buddhist and Jaina texts like Visuddhimagga⁵⁶ and Tattvārthādhigama Sūtra’s Bhāṣya⁵⁷ respectively. Besides, it is also recorded in the Jaina Āgama Bhagavatī Vyākhyāprajñapti.⁵⁸

In the history of the etymology of the word ‘Indriya’ there are mainly two things to be noted – the one is that the Buddhist grammarian Panini’s commentator have given place to that etymology in their respective works in details, while. Ācārya Hemchandra,⁵⁹ the Independent Jaina grammarian also has given position to it in his own Vyākaraṇa

51. Pañṇavāṇā Sūtra I. 15 Indriyapadam, Saṁṭhāṇadāram.

52. Ibid., Puṭhadāraṁ, Indriyapadaṁ.

53. Biology, p. 382.

54. Ibid.

55. Indriyamindralingam indradṛṣṭamimdraṛṣṭamindrajuṣṭamindradattamiti 5.2.93

56. VM. XVI, Indriyasaccaṇiddesa, 4, 5, 6 ; Darśana and Chintana, p. 134.

57. “Pancendriyaṇi bhavanti / arambho niyamārthah ṣaḍādipratiṣedhārthaśca / indriyamindraliṅgamindraṛṣṭa mindrajuṣṭa mindradattamiti vā” (pā, A. 2.pā. 5, sū 93) / intro jivāḥ sarvadravyeṣvaiśvaryayogat viṣayeṣu vā paramaiśvaryayogat, tasya liṅgamindriyam, liṅganāt sūcanāt pradarśanādupaṣṭambhanād – vyañjanācca jivasya liṅgamindriyam”, TS. Bhā., II. 15, p. 162,

58. Bhs., 1-7-61.

59. ‘Indriyam’, Hemaśabdānuśasanam, 7.1.174, p.128.

Sūtra and Vṛtti in full details. The other point is that the etymology of the word Indriya' is not found in any Vedic philosophical work except in the very oldest commentarial works of the Pāṇini Sūtra, just as it is come across in the Buddhist and Jaina texts. It is known that the etymology of the word 'Indriya', having found place in the Buddhist and Jaina philosophical treatises, became the subject of speculation of the philosophers. As for example, in the Māṭharavṛtti,⁶⁰ the oldest Vedic philosophical treatise, there is preserved the etymology of the word 'indriya', but it is quite different and distinguishable from that recorded in the Buddhist and Jaina works. It is gratifying to note that when the nirukti (etymology) of this word 'Indriya', having left the field of word, entered into that of the philosophy, then the stamp of the philosophical community got impressed on it. Buddhaghoṣa⁶¹ speaks of all those meanings as spoken of by Pāṇini in the nirukti of the word 'Indriya', but he has made attempt to adopt it by starting the meaning of Indriya as Sugata.⁶² The Jaina Ācāryas interpret the meaning of the word 'Indriya' as only Jiva generally, they have not made the meaning of it as Tīrthaṅkara like Buddhaghoṣa as desired by himself.

According to the Sāṃkhya, the material cause of the indriyas (sense-organs) is abhimāna (ego) which is a kind of fine substance produced from the Prakṛti.⁶³ This view is acceptable to the Vedānta. The Nyāya⁶⁴ maintains that the cause of the indriyas is the five elements like earth, etc., which are nothing but non-living substances. This view is acceptable also to the Pūrva Mīmāṃsakas. According to the Buddhist Philosophy, the five sense-organs, because of being produced from Rūpa (Matter), are called rūpa (Matter), which is particularly non-living. Jaina Philosophy also makes reference to particular matter as the cause of the gross physical sense-organs (dravyendriyas), which is a particular non-living substance only.

The external shapes like karṇaśākuli, akṣigolakakṛṣṇasāra, triputikā, jihvā and carma (ear-drum, eye-socket-pupil, nose, tongue and skin),

60. "In iti viṣayāṇām, nāma, tānīnāḥ viṣayān prati dravantīti indriyāṇī" Māṭharavṛtti, kā 26, p. 43.

61. "See Tippaṇī, 2, Darsāra and Cintāna, p. 134.

62. "Ko pana nesām indriyāṭṭho nāmāti ? indalīṅgaṭṭho ; indriyāṭṭho ... bhagavā hi sammāsaiṁ buddho paramissariyabhāvato indo..... atthātovinischayo /", VM. XVI, 4, 5. 6.

63. Sāttvika ekādaśakāḥ pravartate vaikṛtādahankārāt / Bhūtādestanmāṭraḥ sa tāmasaḥ, taijasādubhayaḥ // Sāṃkhya-kārikā, 25.

64. "Ghrāṇa-rasana-nacakṣu-stvak śrotrāṇīndriyāṇī bhūtebhyāḥ", NS., 1.1.12.

which the common people call by the order of the name – karṇa, netra, ghrāṇa, rasana and tvak-indriyas (sense-organs of hearing, sight, smell, taste and touch) respectively, have been accepted as indriyādhiṣṭhanas⁶⁵ (places or substrata of sense-organs) in all Indian systems of thought, but not as indriyas. Indriyas have been accepted as intangible entities existing in those shapes whether they are material or egoistic. Jaina Philosophy, having accepted those material adhiṣṭhānas (places or substrata) as dravyendriya (physical sense-organ) even, has indicated the same idea that adhiṣṭhānas (places of or substrata sense-organs) are not really the indriyas. According to this school, the indriyas are intangible, but they, being not material (bhautika) or egoistic non-living substance, are consciousness like or sentient capacity-like which is called bhāvendriya (psychical sense-organ) by the Jainas. The sixth indriya called manas (mind) has been accepted as the internal sense organ in all Indian systems of thought. Like this six buddhīndriyas (organs of intellect) are common to all philosophies, but it is only the Sāṃkhya Philosophy which mentions eleven indriyas⁶⁶ by counting the five karmendriyas (sense-organs of action), viz. speech, hands, foot, anus and the organ of procreation⁶⁷ as indriyas. Just as Vācaspati Miśra and Jayanta⁶⁸ spoke against the acceptance of the karmendriyas (the sense-organs of action) of the Sāṃkhya as indriyas, just so Ācārya Hemacandra also, having refuted the indriyatva (the state of sense-organ) of the karmendriya, followed the previous Jaina Ācāryas like Pūjyapāda and others who argued in this manner. “This is the section dealing with consciousness. Those that are the instruments of consciousness alone are mentioned here, and not those that are the instruments of activity as these have no such limit. All the limbs and minor limbs are the instruments of activity. And these are determined by nāma-karmas of limbs and minor limbs. Moreover, the instruments of action are not five only”.⁶⁹

Here the question arises when Ācārya Pūjyapāda and other old Jainācāryas and scholars like Vācaspati, Jayanta and others have forcefully refuted the eleven indriyas of the Sāṃkhya, then why have they

65. Nyāyamanjari p. 477.

66. “Abhimāno’ ahaṅkārastasmād dvividhaḥ pravartate sargah / Ekādaśakaśca gaṇastanmatraḥ pañcakaścaiva //” Sāṃkhya-kārikā, 24.

67. “Buddhīndriyāṇi cakṣusrotraghṛāṇārasanāsparsanakāni / Vākpāṇipādāpāyūpāsthan karmendriyāṇyāḥuḥ //, Sāṃkhya-kārikā, 26,

68. Tatparyātikā, p. 531; Nyāyamanjari, p. 483.

69. “Pāñcendriyāṇi bhavanti / ārambho niyamārthaḥ saññādipratiśedhārthaś ca/” TS. Bhā.. p. 162; Sarvārthaśiddhi, p. 174.

not denied or mentioned the number of twenty-two indriyas which are well-known in the Buddhist Abhidharma work.⁷⁰ It is known that in the Buddhist Abhidharma tradition there was a common custom of referring to every mānasāśakti (mental power) by the word 'indriya'. Having thought thus, they have not mentioned or refuted that tradition. Objects like sound, colour, smell, taste, touch, etc., are always apprehensible to the six sense-organs. In this regard all the systems of thought are of one view, but there is the difference of opinion of the Nyāya-Vaiśeṣika from all other systems of thought with regard to the apprehensibility of substance by the indriyas (sense-organs). All other philosophies, even having accepted indriyas as the apprehenders of quality, admit six sense-organs as the apprehenders of substance, while the Nyāya-Vaiśeṣika and the Pūrvamimāṃsaka call eye, tactile organ (sparśanendriya) and mind as the only apprehenders of substance, but not others.⁷¹ Ācārya Hemacandra has expressed this difference of opinion, having spoken of karmabhāva-pradhānavyutpatti of the words, such as, sparśa (touch), etc., and along with it he followed the previous Ācāryas.

The discussion on indriya-ekatva (singleness or oneness of sense-organ) and multiplicity of indriyas is very old in the metaphysical tradition.⁷² Some, having accepted the sense-organ as one, have supported its many functions by its sthānas (places), while all the advocates of the multiplicity of sense-organs maintained only the principle of multiplicity sense-organs by refuting the view of singleness of the sense-organ. In regard to this Ācārya Hemacandra, having recourse to the method of the relative point of view, followed the Jainācāryas by making a synthesis of both the theories, i. e. mutual singleness and multiplicity in the sense-organs, and avoided the faults attributed to each other in the case of every extreme view.

Indriyas (sense-organs) are of two kinds, viz. Dravyendriya (physical sense-organ) and Bhāvendriya (psychic sense-organ) Dravyendriya, because

70. 'Dhatūnām anantaryam uddhiṭṭhāni paṭa, indriyāni ti bāvisati indriyāni; cakkhundriyam sotindriyam ghānindriyam jivhindriyam kāyindriyam manindriyam itthindriyam purisindriyam jivindriyam sukhindriyam dukkhindriyam somanas-sindriyam domanssindriyam upekkhindhriyam, saddhindhriyam viriyindriyam satindriyam smādhindhriyam, paññindriyam, anaññātanassāmitindriyam aññindriyam aññātavindriyam ti', VM. XV II.
71. Abhidharmakośa Sphuṭarthā p. 95; VM., XVI. 1,2, ff see Darśan and Cintan, p. 137. ..
72. Muktāvali, kā, 53-56
73. "Sthānānyatve nānātyādavayavinaññāsthānatvācca samśayaḥ /", NS., 3.1.52,
74. "Dvividhānindriyāṇi bhavanti – dravyendriyāṇi bhāvendriyāṇi ca /", TS. Bhā., II. 16, p. 163.

of being produced from matter is non-living matter—because it is the mode of *cetanaśakti* (capacity of consciousness).⁷⁵ *Dravyendriya* is produced by the rise of *āngopāṅga* (limbs)—and *nirmāṇanāmakaṛma* (i. e. constitution—making—nāma karma).⁷⁶ There are stated to be two divisions of it, viz. *nirvṛtti* and *upakaraṇa*⁷⁷ (accomplishment and means). The name of the shape of the sense-organs is *nirvṛtti*. It is also divided into two kinds, viz. *bāhya* (external), and *ābhyanṭara* (internal).²⁴ The external shape of the sense-organ is called *bāhyanirvṛtti*, while the name of the internal shape is *ābhyanṭara nirvṛtti*. The external part is just like the sword, while the internal part is like the sharpness of it which is made of very fine translucent atom. Both material and psychical natures of the internal *nirvṛtti* have been described. *Upakaraṇa* is the means of *nirvṛtti*; it is also external and internal.²⁵ In regard to the shape of the sense-organs it should be noted that there are many kinds of shape of skin, as already pointed out but there is no difference in its external and internal shapes.

The internal shape of skin of any being is just like the external shape of skin.²⁶ But in the case of other sense-organs it is not so. Except skin the internal shape of all other sense-organs are not identical with their external shapes. The internal shapes of kindred sense-organs of all classes of animals have been accepted as of one and the same type. As for instance, the internal shape of the ear is like the shape of a kadamba-flower, that of the eye is like the lentil, that of the nose is like the atimuktaka flower, that of the tongue is like khurupa (dagger or weeding agricultural implement). The internal shape of the skin is of different kinds. The external shapes of all the sense-organs are different in all cases of animals, as for example, the ears, eyes, noses and tongues of man, elephant, horse, cow, cat, rat, etc.²⁸

75. "Sāmānyataḥ dravyamayāṇi dravyātmkāni dravyendriyaṇi bhāvendriyāṇi tu bhāvatmakānyātmapariṇātirūpāṇīti /" TS. Bhā., 164.

76. Ibid., p. 164.

77. "Nirvṛttypakaraṇe dravyendriyāṇi" TS., II. 17;

78. "Nirvṛttiraṅgopāṅganāmanirvartitānindriyadvārāṇi, karmavīgeśasāṁskṛtāḥ śarīra-pradeśāḥ nirmāṇanāmāṅgopāṅgāpratyā mūlaguṇanirvārṭanetyartāḥ", Ibid, p.164.

79. TS. Pt. pp. 164, 165.

80. TS., Pt. I, 165.

81. Bhs., 2, 4. 499 ; Prajñāpanā 15. 191 ; Pancadaśa, Indriyapada, Prathama Uddeśaka, Prajñāpana, pāda, 15 ; Fourth Karmagrantha, pp. 36-37; TS., Ch. II. 17-18 and vṛtti : Viśeṣāva, śyakabhāṣya Gāthā, 2993-3013 and Lokaprakāśi, sūrga, 3, Sl. 464 ff.

82. TS., p. I, pt. 165.

All these five sense-organs are individually an innumerableth part of an aṅgula (finger) by thickness (bāhalla), while ear is an innumerableth part by width (pohattā), thus upto that of the eye and nose; the tongue is one aṅgula (finger) by width (pohatta); and the skin is equal to the extent of the body. These five sense organs are endowed with infinite units (ananta-pradeśikas) and immersed in countless space-points (asamīkhyeyapradeśavagadha). The least of all these is the eye.⁸³

The capacity of apprehending objects by internal nirvṛtti formation is called upakaraneṇdriya.⁸⁴

Bhāvendriya (psychic sense-organ) is of two kinds, viz. labdhirūpa (mental faculty-like) and upayogarūpa (consciousness-like).⁸⁵ The kṣayopaśama of Matijñānāvaraṇa – the particular capacity of consciousness is called labdhirūpabhāvendriya. The pṛavṛtti (action) which takes place in the apprehension of objects by soul according to this labdhirūpabhāvendriya is called upayoga-rūpa bhāvendriya.⁸⁶

According to the Buddhist Philosophy, “The translucent matter of sense-organs (rūpaprasada) is very subtle; it is like the shining of a jewel, it cannot be cut in two,⁸⁷ it cannot be burnt,⁸⁸ it has no weight⁸⁹, it disappears without a residue at death.⁹⁰ It is nevertheless atomic, and is represented by five different kinds of atoms. The atoms of the organ of sight (eaksurindriya) cover in concentric circles the eye-ball. The atoms of the organ of taste, or, more precisely that matter which is supposed to convey the sensation of taste, covers in concentric semi-circles the tongue. The atoms of the organs of touch (kāyendriya) cover the whole body.⁹¹ The idea that all these different kinds of special matter are, indeed, the same translucent subtle stuff covering

83. Paññavānā Sutta 15, Indriyapada, appābhudāram p. 166.

84. TS., Pt. I. p. 164.

85. “Labdhypāyoeu bhāvendriyam/”. TS., II. 18, p. 166.

86. “Labdhirūpayogastu bhāvendriyam bhavati / labdhirnāma gatijātyādināmakarmanājanitā tadāvaraṇāyakarmakṣayopasamajanitā ca / indriyāśrayakārmodayanirvṛttā ca jivasya bhavati /”, TS., Bhā. p. 166.

87. “Chinatti chidyate caiva bāhyam’ dhatu catuṣṭayaṁ / Dahyate tulayatyevam vivādo dagdhetulyayoḥ //”, Abh. K., 1.36 Tibetan, Text, p. 63; Abh. K. 1.36. Yasamitra Comm. 1.36.

88. Abh. K., 1.36, Tibetan, Text, p. 63.13.

89. Ibid.

the whole body and disappearing at death had also its advocates, who consequently reduced all senses to one, the sense of touch. But this did not find general acceptance. Being as subtle as the shining of a jewel, this matter cannot appear alone; it is supported by gross matter (*mahābhūta*), of which the eye-ball and flesh in general consist—⁹².”

The comparative study of Indriyas by all Indian systems of thought in brief reveals that the Jaina view on them from their physical and psychical aspects is more subtle and thought-provoking as they have been accepted as representing translucent matter like that of the Buddhists.

90. “*Vipākajaupacayikāḥ pañcadhyātmām vipākajah/*” *Na śabdo apratighā aśāu*”
naiṣyandikavipākavipākajah /; “*mṛtasyānanuvṛtteh /*” ; *Abh. K.*, 1.37, *Yasomitra*.

91. “*Tribhirghrāṇādibhistulyavīsayagrahaṇām mataṁ / Caramasyāśrayo atitāḥ /*”,
Abh. K., 1.44.

92. *The Central Conception of Buddhism*. pp. 10-11.

(Ninth Section)

THE ENDOCRINE SYSTEM

The integration of the activities of the various parts of the bodies of higher animals is achieved by two co-ordinating systems – the nervous system, (*ṇhārūs*) as already discussed, and the endocrine system. (stomach, liver, kidney, ovaries, testes, etc.). The long-term adjustments of metabolism, growth, reproduction are typically under the control of the endocrine system.

As found in Jaina Biology, the endocrine system consists of stomach, liver, kidney, ovaries, testes, etc. Modern Biology adds to them pineal gland, pituitary gland, thyroid gland, parathyroids and thymus, adrenals, etc.¹

Stomach (*āmrū* or *udara*),^{1a} liver (*Kāhjjam* or *yakṛt*) and kidney (*taṇuyamta?*)^{1b} have already been discussed in the sections on “Digestive and Excretory systems”. Ovaries (*Kucchi=Kukṣī*)² and testes (*Vasāṇa - aṇḍakāṣā*)³ have both external secretions, via ducts and internal secretions carried by the blood stream. “The endocrine glands are distinguished by the fact that they secrete substances into the blood stream rather than into a duct leading to the outside of the body or to one of the internal organs.”⁴

According to modern Biology, “some glands—thyroid, parathyroids, pituitary and adernal function only in the secretion of hormones and are strictly ductless glands ; others, such as, the pancreas, ovaries, and testes have both external secretions carried by the stream.”⁵

Testes :

In addition to cells that manufacture sperm (*sukka*),^{5a} “the testes contain cells that produce, the male sex hormone, testosterone”.⁶ It is

1. Biology, p. 389.

1/a Kalyāṇakāraka 3.4, Tandula Veyāliya 17, p. 38.

1/b Tandula Veyāliya 16, p. 35.

2. Tandula Veyāliya 2. p. 6. Ovaries are connected by 2 fallopian tubes

3. Paṇhavāgarāṇa 1.3 ; see Pāśadda māhāṭman, p. 752.

4. Biology p. 38.

5. Biology p. 388.

5/a Tandula Veyāliya 16, p. 35 ; sthānāṅga 5 (*sukkapoggale*)

6. Biology, p. 399 ; Sukka, Tandula Veyāliya. 2, p. 6.

suggestive from the mention of ten Śukradhāriṇī śirās⁷ (seminal ducts) that “these hormone cells are located between the seminiferous tubules which produce sperm”. “Testosterone stimulates the development of the so-called secondary male sex characters – the beard śmaśru), the growth and distribution of hair on the body, the deepened voice, the enlarged and stronger muscles and the accessory gland, seminal vesicles and penis”.⁸

The Ovaries⁹ (Kucchi)^{9/a}

Like the testes, ovaries are endocrine glands and secrete soṇiyātavayā (drops of blood) in addition to producing eggs (ojas) for reproduction.¹⁰ “Both ovaries and testes develop from mesoderm, from the genital ridge on the Ventral side of the mesonephric kidneys,”¹¹ according to modern Biology.

The two fallopian tubes of two ovaries are puṣpanālikākāra¹² (of the shape of the stalk of lotus or flower). According to Biology, “the two ovaries are beam-shaped structures, about 1 1/2 inches long, supported in the back part of the abdominal cavity by mesenteries. The outer layer of each gland is the germinal epithelium, from which the eggs develop, while the central part is composed of connective tissue and blood vessels. Just under the germinal epithelium is a thick layer of spherical groups of cells or follicles, each enclosing one egg.”¹³

It is indicative in Jaina Biology that each month,¹⁴ one or more

7. Tandula Veyāliya, 16, p. 35.
8. Biology, p. 399 ; Tandula Veyāliya, p. 6.
“Mehanāṁ Kharatā dārḍhyam gaṇḍīryam śmaśrujdhṛṣṭā/strikāmiteti lingāni, saptā pūṁstve pracakṣati /” Tandula Veyāliya, p. 6.
9. Tandula Veyāliya p. 3, Reference to fallopian tubes sirādugam suggests the existence of ovaries. Tandula Veyāliya p. 3.
- 9/a Ibid 16, p. 35, p. 39.
10. Itthie nābhihiṭṭhā sirādugamte riukāle phuṇḍiyā soṇiyalavayā vimoyaṁti II, Ibid, p. 3
11. Biology, p. 400
12. Tandula Veyāliya, p. 3.
13. Biology, p. 400
14. Itthie nābhihiṭṭhā sirādugam pupphanāliyāgāraṁ / tassa ya hiṭṭhā yoni ahomuhā saṁthiyā kosa (9) II / Tassa u hiṭṭhā cūyassa māṁjari (jārisi) tārisā u māṁsassa/ te riukale phuṇḍiyā soṇiyalavayā Vimoyaṁli // Kosāyāraṁ joṇim saṁpattā sukkamisiyā jaiyā / taiyā jivuvavac juggā bhaṇiyā jiniṁdehim // Tandula Veyāliya p. 4.

Māsi māsi rajaḥ striṇāmajasraṁ śravati tryahāṁ” Sthārāṅga Tīka, vide Tandula Veyāliya p. 4.

of the follicles begins to enlarge and become distended with follicular fluid, until finally protrudes above the surface of the ovary and bursts, releasing (Vimoyimti) the egg cell contained in it. This process is known as ovulation¹⁵ (rtu). The released egg passes by way of a channel called oviduct (sirādugam̄ pupphanāliyagāram̄) to the uterus (yoni).¹⁶ If the egg metes and is fertilized by a sperm (Sukkamisiya yaiya) in the upper part of the oviduct, it eventually becomes embedded in the uterine wall and begins to develop into an embryo.¹⁷ If no sperms are present, the egg degenerates.¹⁸

“ Whether or not fertilization occurs, the follicular cells left after the rupturing of the follicle in ovulation multiply rapidly and fill the cavity left by the previous follicle¹⁹. ”

Estrous and Menstrual Cycles :

In most mammalian species, the females demonstrate rhythmic variations in the intensity of the sex urge.²⁰ “ The period when it is at its height is known as estrus in Biology and the animal is then said to be in “heat.”²¹

The estrous cycle is marked not only by the changes in the lining

15. Tassa ya hiṭṭha chuyassa māṁjari (jārisi) tarisā u māṁsassa / te riukāle phuḍiyā soṇiyalavayā vimoyam̄ti 10. Tandula Veyāliya, p. 3.
16. Tessa ya hiṭṭha joni ahomuhā saṁthiya kosā / Kosāgāram̄ joniṁ saṁpattā sukkamisiya jaiyā / tayiā jīvavāvāe jugga /” Tandula Veyāliya, p. 3.
17. “Kosayāram̄ joniṁ saṁpattāe sukkamisiya jaiyā /
taiyā jīvuvavāe juggā bhaniyā jīṇimdehim //” Tandula Veyāliya p. 3.
“Pamcahim ṭhāṇehimitti puriṣena saddhiṁ asaṁvasamāṇivi gabbhaṁ dharejjā, taṁoutthi duvvippayadā dunnisannā sukkappogale adhiṭṭhijjā/sukkappoggalasaṁsaṭṭhe va se vatthe aṁto yoṇie aṇupavesejjā 2 sayam̄ va se sukkapoggale 3 paro va se sukkapoggale aṇupavesejjā, siodagaviyaḍena va se āyamāmānie sukkhapoggale aṇupavesejjā, iccetehim paṁcavadharejjā Sthānāṅga Sūtra 5 vide Tandula Veyāliya, pp. 3-4.
18. “Bārasa ceva muhuttā uvarim vidhāṁsagacchāi sā u /”
Tandula Veyāliya p. 4
19. Biology, p. 460.
20. “Pamcahim ṭhāṇehimitti puriṣena saddhiṁ asaṁvasamāṇivi gobbaṁ dharejjā, taṁ duvvippayadā duvvippayadā dunnisannā sukkappoggalasaṁsaṭṭhe va se vatth: aṁto yoṇie aṇupavesejjā 3, etc.” Thānāṅga 5
21. Biology, p. 401

of the vagina and uterus which make the latter better able to receive a fertilized egg.²²

Jaina Biology indicates that the uterine lining becomes softer and thicker, while its blood vessels and glands increase in number and size. These processes reach their height a short time after ovulation (Riukāla)²³ The Jaina view on menstruation every month is supported by Indian modern Biology in this manner that "Human antheropoid" ape females do not experience any distinct period of estrus; instead the cycle is marked by periods of bleeding, known as menstruation, which occur about every twenty-eight days and last about four days. The menstrual flow consists of pieces of the ruptured uterine lining and blood from its vessels.²⁴,"

After the egg has been released from the ovary and is passing down the oviduct, it can be fertilized only within a short time, probably about twenty-four hours (Bārasa ca muhuttā uvarim viddhamsagacchae sāu).²⁵ When the sperm are deposited, through intercourse in the female reproductive system, they quickly lose their ability to fertilize an egg, within forty eight hours at the most²⁶. The period of maximum fertility in human beings, then, narrows to the time of ovulation, about midway between successive menstrual periods.

The placenta (Mātrjivarasaharaṇi)²⁷

Although the placenta, (matrjivarasaharaṇi) is primarily an organ for the support and nourishment of the developing embryo, it is also an endocrine gland. According modern Biology, "it secretes estradiol, progesterone, adrenal corticoids and chorionic gonadotropin, a substance similar to the luteinizing hormone of the pituitary.²⁸

22. Tassa ya hiṭṭhā joni ahomuhā saṅṭhivā kosā (9) tassa ya hiṭṭha cūyassa māṇjari (jārisī) tarisā u māṇsassa / te riukāle phuḍiyā soṇiyalavayā vimoyānti Kosāyāraṁ joniṁ saṁpathā sukkamīsiyā jaiyā / taiyā jivuvavāc juggā bhamiyā jinimdehim." Tandula Veyāliya, p.3.
23. Tassa yā hiṭṭi cūyamāṇjari ... te riukāle phuḍiyā soṇiyalavayā Vimoyānti Tandula Veyāliya p. 3.
24. Biology, p. 4.1
25. Tandula Veyāliya p. 4.
26. Ibid.
27. Bhagavati Sūtra 1.7.61 Tandula Veyaliya 4, p. 9
28. Biology, p. 403,

Other Endocrine Glands :

According to Biology, "certain other organs of the body, although not usually considered endocrine glands, do produce hormones. These include the small intestine, (which yield secretin, responsible for the flow of pancreatic juice,) and the hormone cholecystokinin, which stimulates the contraction of the gall bladder."²⁹

"The stomach, liver and kidney also are believed to have endocrine functions but the evidence for this is not yet conclusive."³⁰

"The thymus, a fairly large gland, existing only during childhood, lies in the upper part of the chest, covering the lower end of the trachea."³¹

"The pineal glands, a small, round structure on the upper surface of the thalamus, between the two halves of the cerebral cortex, has long been suspected of endocrine activity, largely because it has no other known function."³²

29. Biology, p. 403

30. Ibid;

31. Ibid, p. 403

32. Ibid. ; see Jolley's chart on Anatomy, vide Brahmavidyā Vol. XXXVIII, 9.75.
Dr. Mrs. Colette Caillat on the medical doctrines and anatomy in Tandula Veyāliya.

(FIFTH CHAPTER)

Reproduction :

ASEXUAL AND SEXUAL REPRODUCTIONS, HUMAN REPRODUCTION AND EMBRYONIC DEVELOPMENT.

(First Section)

Reproduction Asexual Reproduction and Sexual Reproduction.

The survival of each species of plant or animal requires that its individual members multiply¹ that they produce new individuals to replace the one killed by predators,² parasites³ or old age⁴ and disease⁵. The actual process of reproduction varies tremendously from one kind of animal to another,⁶ but two basic types of reproduction, Saṁmūrcchima and Garbhavyutkrāntika,⁷ can be distinguished. Even the highest animals reproduce asexually as evidenced by the fact that “the production of identical twins from the splitting of a single fertilized egg, is a kind of asexual reproduction.”⁸

Saṁmūrcchima⁹ (asexual birth or reproduction) involves only a single parent, (i.e. it does not require parent) which splits, buds or

1. Sūtrakṛtāṅga II. 3. 19, etc.
2. Sūtrakṛtāṅga II. 3. 17, “macchānam susumāranam.....egadescṇām oyaṁahareṁti, etc. e.g. fishes, porpoises, as long as they are young, they feed on the mother’s humours, or both movable and immovable beings.
3. Sūtrakṛtāṅga II. 128 (ānusūya) “ānusūttāe viuṭṭamīti”
4. Jarāc pariṇāmao.... Jarāghare viṇassamīte, jivo vasaiakāmao” // 9 // (40), etc. Tandula Veyāliya 41, p. 16.
5. “Himābhinnasāro diṇo, vivario vicittao /”.... dubbalo dukkho suyai /” Ibid. “duhkito – rogādipīḍālakṣavyāptah”, Ibid (comm.), p. 17 old age (jarā) and disease (roga) are the two of the ten conditions of life. Ibid (comm.)
6. Sūtrakṛtāṅga II. 3 ; Paññavaṇā I. Jivapāṇavāna, ; see births of Beiṁdiya – to pañcēṁdiya Jivas – Saṁmūrcchima and Vyutkrantika, etc. Tāttvārthādhigama Sūtra, II. 24, 34.
7. Bhagavati Sūtra 7.5 282 ; Jivābhigama 3.1.96 ; 1.33.36
Uttarādhyayana XXXVI. 171 ; Paññavaṇā Jivapaññavaṇā (from two-sensed to five-sensed animals).
8. Biology. p. 411. See Uttarādhyayana Sūtra, XXXVI 170. All pañcendriyas are both Saṁmūrcchima and Garbhaja, (i. e. they have asexual and sexual reproduction).
9. Bhagavati, 7.5.282 ; Jivābhigama Sūtra 3.1.96 1-33.36. Uttarādhyayana Sūtra XXXVI. 170 ; Paññavaṇā Jivapaññavaṇā. 1.57, p. 27 see dvindriya to pañcendriya Jivapaññavaṇā.

fragments to give rise to two or more offsprings which have hereditary traits identical to those of the parents.¹⁰ Garbhavyutkrāntika (Sexual reproduction) involves two parents,¹¹ each of which contributes a specialized or gamete (eggs and sperm)¹² which fuse to form the zygote or fertilized egg.¹³

According to modern Biology, "The egg generally is non-motile and large, with a store of yolk to supply nutrients for the embryo which results when the egg is fertilized; sperms are usually small and motile, adapted to swim actively to the egg by beating of its tail. The biologic advantage of sexual reproduction is that it permits the recombination of the best inherited characteristics of the two parents; thus offspring may be better able to survive than either parent".¹⁴

Asexual Reproduction (Sammūrcchima Vakkaṁtiya)¹⁵

Living things or animals can give rise to a new generation asexually in a number of ways, such as, by fission among the single-celled animals like kṝmis (worms) and Kukṣikṝmis (amoebas)¹⁶ and by budding, e. g. "yeasts",¹⁷ according to modern Biology.

It is observed that many higher animals, such as, lizards (gṝhagoli-kāś),¹⁸ etc. can grow new tail or other organ if one is lost. "When this ability is carried to an extreme, it becomes a method of reproduction, called fragmentation. The entire body of the parent may break

10. Offspring of two-sensed or three-sensed animals born by the process of asexual reproduction have hereditary traits identical to those of the parents, e.g. worms (Kṝmis), etc.
11. All five-sensed animals are both saṁmūrcchima and Garbhavyutkrāntika, i. e. from five-sensed lower animals to man, all have asexual and sexual reproduction. See Uttarādhyayana Sūtra XXXVI 1'0; Paññavanā, Jivapaññavanā, Tirikkhivapaññavanā upto Manussajivapaññavanā.
12. Sūtrakṝtāṅga II. 3. 21. "Itthie purusassa ya kamma kaṭai joṇie etthia nām mehuṇavattiyāe nāmaṇ saṁjoge samayjjai" "te rudhirabindavaḥ koṣākāraṁ yonīṁ saṁprāptaḥ santāḥ ūkramiśritāḥ ṣṭudinatrayānte puruṣasamyogena apuruṣasamyogena vā puruṣaviroṇa militāḥ yadā bhavanti tadā jivotpāde - garbhasam-bhūtilakṣaṇeyo gyā bhaṇita." Tandula Veyāliya, p. 5.
13. Ibid.
14. Biology.
15. Bhagavatī Sūtra 7.5.2'2; Jivābhigama Sūtra 3.1.96; Uttarādhyayana Sūtra XXXI 170. ; Paññavanā Sutta, Jivapaññavanā.
16. Paññavanā, Veinādiyajivapaññavanā.
17. Biology, p. 418.
18. Tattvārthādhigama Sūtra II. 34.

into pieces as many as several hundred - each of which develops into a new animal. This is particularly common among the flat-worms,'¹⁹

Some animals and most plants reproduce, asexually by means of spores,²⁰ which are special cells with resistant coverings, e. g. maśaka, "the single-celled animal plasmodium, which causes malaria. "The organism has a complex life cycle involving both man and the Anopheles mosquito."²¹

Sexual Reproduction in Animals. (Garbhavyutkrāntika)²²

According to Jaina Biology, a few animals, such as, five-sensed lower animals (tirikkhajoṇiyajivas),²³ have alternate sexual and asexual generations,²⁴ but most of them reproduce solely by sexual means,²⁵ and have permanent sex organs. Modern Biology mentions the coelenterates which have alternate sexual and asexual generations, but "most animals having permanent sex organs reproduce solely by sexual union."²⁶

Many species of five-sensed lower animals farther along the evolutionary scale, have permanent structures,²⁷ for sexual reproduction. Among the Vertebrates a wide assortment of accessory structures has evolved to facilitate the union of egg and sperm, and to ensure the development of the embryo.²⁸

1. Biology, p. 419.

20. See Uttarādhyayara Sūtra XXXVI. 146 (masagā) ; Pañṇavaṇā Sutta 1.58.

Some of the four-sensed animals e.g. maśakas (mosquitoes), etc. reproduced by spores. TS. II. 24. ; Biology, p. 49

21. Biology, p. 419.

22. Bhagavati Sutra 7.282. ; Jivābhigama Sūtra 3.1.6 etc. ; Uttarādhyayana Sūtra XXXI. 170 ; Pañṇavaṇā Sutta, Parameṣṭhiya Tīrakkhajoṇiyajivapañṇavaṇā.

23. Pañṇavaṇā Sutta, I, Tīrakkhivapañṇavaṇā 61-91.

24. Some aquatic animals, fish etc and some terrestrial animals, egakhurā, etc. are mentioned as Saṁmūrcchīma and garbhavyutkrāntika. "Te samāsato duvihā pannattā / taṁjāhā - saṁmūrcchīma ya gabbhavakkamtiya ya /". Ibid.

25. Ibid.

26. Biology, p. 420.

27. Sūtrakṛtāṅga II. 3.36 "Itthie purisassa ya Kammakadāe joṇie ettha mehuṇavattiyāe-saṁjoge samuppajjai/" Tandula Veyāliya. "Itthie nābhihiṭṭhā siradugam pupphanāliyāgāram / tassa ya hiṭṭhā joṇi ahomuhā saṁhiṭyā kosā // 9 // tassa ya hiṭṭhā cuyassa marūjari (jārisi) tārisā u marūsassa, etc., p. 3.

28. "Itthie ya purisassa ya kammakadāe joṇie mehuṇavattiyāe nāmaṁ saṁjoe saṁuppajjai, te dibao siñchāni saṁcinaijīti tattha naṁ havvamāgacchati /".

Types of Fertilization.

Most aquatic animals²⁹ simply libérate their sperm and eggs into the water and their union occurs by chance as suggested by the fact that they are *samīkṛchmasjivas*. "No accessory structures are needed, except the ducts that transport the cells to the outside of their bodies. It is called external fertilization for obvious reasons."³⁰ When the development of the fertilized egg takes place out of the female's body, it is called oviparous (*andaja*), when it takes place in the uterus it is called viviparous (*jarāyuja*) e. g. mammals.

Other animals, especially those living on land,³¹ have accessory sex organs for transferring the sperm from the body of the male to that of the female, so that fertilization occurs within the latter³². It is called internal fertilization which requires co-operation of the sexes³³ and "many species have evolved elaborate patterns of mating behaviour to insure that it takes place."³⁴

As it appears from the study of Jaina Biology, the evolution of instincts for the care of the young has accompanied the evolution of more efficient methods for bringing about fertilization.³⁵ Biology observes that "Fish and amphibia (frog) in general take no care of the developing eggs, and great quantities are laid each year in order that by chance a few will develop. The eggs of reptiles are usually laid in the sand or mud, where they develop without parental care, warmed only by the sun. Birds lay their eggs in nests, and incubate them by sitting

29. Biology, p. 420 Bhagavatī, 2.5.105.

30. Paññavaṇā Sutta 1.62 ; Macchā 1 kacchahā 2 gāhā 3 magarā 4 su-usumārā (fish tortoises varanidae (Lizards, Reptili) coscodiles, dolphins), etc. appear to libérate their sperm and eggs into the water.

31. Biology, p. 420.

32. Taṭvārthādhigama Sūtra II. 34

33. Cauppāyathalayarapānīcēmīyatirikkhajōṇiyā ya parisa-patalayarapānīcēmīyatirikkhajōṇiyā ya /" Qūad'uped - terrestrial five - sensed lower animals, and terrestrial five sensed animals which move on breasts and arms respectively. Paññavaṇā Sutta, 1.69

34. "Te samāsato duvihā paññattā / tamjhā - saṁmucchimā ya Gabbhavakkāmītiyā ya", Ibid. 1.75 ; 1.84. Fertilization occurs in the female animals due to the transfer of sperm from the sex organ of the male to that of the female. Tandula Veyāliyā, p. 3; Sūtrākṛtāṅga II. 3.56.

35. Gabbhavakkāmītiyā means that those terrestrial animals are born as a result of internal fertilization which requires the co-operation of both the sexes. The quadrupeds, reptiles, aerial animals have different pattern of mating behaviour.

on them. The newly hatched birds are quite helpless and require parental attention for several weeks.³⁶

"In contrast to these eggs which develop more or less at the mercy of the environment, the mammalian egg...develops within the uterus of the female, where it is safe from predators and from environmental changes until it is able to cope with them."³⁷

In the evolution of the Vertebrates from fish to man,³⁸ the trend has been toward the production of fewer eggs, and the development of instincts for parental care of the young.³⁹ It is indicative that the fish⁴⁰ produces "eggs a year, which develop into adult fish, while mammals⁴¹ have few offspring," but take such good care of them that the majority reach adulthood.⁴²

In the Vertebrates a number of accessory structures⁴³ have developed to facilitate the transfer of sperm from the male to the female reproductive tract⁴⁴ and to provide a place for the development of the fertilized egg.⁴⁵ "These structures have evolved either from or with the urinary system, and the two systems together are frequently referred to as the urogenital system"⁴⁶ in modern Biology.

36. Biology, p. 421.

37. Tattvārthādhigama Sūtra II 34. The following classes of animals—Aṇḍaja—oviparous (fishes, Reptilia, Batrachia), Jarāyuja (mammals born with placenta, including all mammals other than the potaja) and potaja (a class of placental mammals comprising the Dec duata with the exception of Man, the Apes and the carnivora) indicate that the evolution of more efficient methods for bringing about fertilization has been accompanied by the evolution of instincts for the care of the young.

38. Biology, p. 421.

39. Biology; p. 421.

40. Pañṇavānā I. 63–92.

40/a Sūtrakṛtaṅga II. 3 (See Ahāraṇkṣepa for the bringing up of mammalian young kiddies)

41. 'Sūtrakṛtaṅga II. 3.22. 'Aṇḍajānām ...matsya, etc.', TS. II. 34.

42. "Jarāyujānām manusya – go – mahīṣajāvikaśa upto mārjārādinām. "Potajānām ḡallaka – hasti..garbhe jaṭma /", TS. II. 34.

43. Biology, p. 421.

44. 'Ithīś nābhīhiṭṭha sirādugām pupphāṇāliyāgārām / tassa ya hiṭṭha yoni ahamuhā samīṭṭhiyā kosā // ७ // Tassa ya hiṭṭha cuyāssa mamjari (jārisi) tārisā u māṁsassa / Tandula Veyāliya, p. 3.

45. "Te riukāle phuṇiyā soṇiyalavayā vimoyāmi o kosāyāram joṇiṁ sāṁpattā sukkamīsiya jaiya / taiya jīvuvavāh juggā //", Ibid.

46. Biology, p. 421.

(Second Section)

HUMAN REPRODUCTION.

Human reproduction,¹ in common with that of most animals, is accomplished sexually by the union of specialized gametes – ova or eggs produced by the female and sperm produced by the male.² A man and a woman combine in cohabitation in a cunnus (Jōnie) and there they deposit their humours (siñeham). Therein are born the souls of different men.³ That is to say, “all the parts of the complicated reproductive system in both sexes, as well as the various physiologic and psychologic phenomena associated with sex, have just one purpose to insure the successful union of the egg and sperm, and the subsequent development of the fertilized egg into a new individual.”

The Male Reproductive organs :

The testis (vasaṇa) discussed previously as an endocrine gland, performs an equally important function as the source of the male sex cells.⁵ Jaina Biology refers to sperm duct or seminal vesicle (śukradhāriniśīrā),⁶ penis (upastha),⁷ sperm or semen (Śukka)⁸ etc. But like modern Biology it does not go into the detailed descriptions of the male reproductive or gans-scrotal sac, testes, seminiferous or testicular tubules, vas efferens, epididymis, vas deferens (sperm duct), seminal

1. Kosāyāram joñiñ samptattā sukkamisiyā jaiyā taiyā Jivuvavāe juggā bhaṇiya bhaṇiyā jiniñdehim”, Tandula Veyāliya. p. 3.

2. Ibid.

“Pamcahim ḫāñehimittī purisēṇa saddhīñ asaṁvasamāñīvī gabbham dharejjā, tam-itthi duvvippayadā dunnisannā sukkā oggale adhiñhijja, sukkapoggalasam-satthe vā se vatthe arñto jōnie añupavesejjā 2 sayāñ va se sukkapoggale añupavesejjā 3 paro va se sukkapoggale añupavesejjā 4 siodagaviyaṇe na vā se ayamamānie sukkapoggle añupavesejjā 5 iccetehim pañcajāvadharejjā /”, Sūtrakṛtāṅga II. 3, 56 Sthānāṅga Sūtra, pamcamosthāna

3. Sūtrakṛtāṅga II. 3. 56

“Tesiṁ ca नाम् अहाबिनाम् अहावगासेनाम् इथी पुरिसास्या कम्मकादाम् जोने एथा नाम् नेहुवावत्तियै (वा) नामाम् सम्भोगे समुपपज्जाय दुहावी सिनेहम् साम्चिनाम्ति / तत्था नाम् जीवा इथित्ताये पुरिसत्ताये नपुंसगत्ताये वित्ताम्ति /”

4. Biology, p. 421.

5. Biology, p. 421.

6. Tandula Veyāliya p. 16, p. 35.

7. Tandula Veyāliya, p. 38,

8. Tandula Veyāliya, p. 3,

fluid, seminal vesicles, prostate glands, cowper's glands, urethra and penis.⁹

According to Biology, a pair of these testes (glands) "develops within the abdominal cavity of all vertebrates, but in man and some other mammals they descend shortly before or after birth into the scrotal sac, a loose pouch of skin which is an outpocketing of the body wall."¹⁰

"Each testis consists of about one thousand highly coiled seminiferous tubules which actually produce the sperm. The seminiferous tubules are lined with a germinal epithelium made up of rounded cells with large muscles. These cells undergo division to form cells which develop into the sperm, with compact heads, containing the nucleus, and a long whiplike tail for locomotion."¹¹

"At one end of each seminiferous tubule (testicular tubule) is a fine tube called the vas efferens, which connects it to a single, complexly coiled tube, the epididymis, where the sperm are stored. Each of the two epididymides lies close to the base of the testis to which it is attached. From each epididymis a duct, the vas deferens (sperm duct), passes from the scrotum through the remains of the inguinal canal, into the abdominal cavity and over the urinary bladder to the lower part of the abdominal cavity, where it joins the urethra.

The sperm are suspended in a liquid, the seminal fluid, secreted from the seminal vesicle and the prostate gland. These secretions together with sperm, constitute semen. The urethra is a tube leading from the urinary bladder to the outside of the body. In the male the last part of it runs through the penis, the external representative organ, just above and in front of the scrotal sac. Within the penis the urethra is flanked by three columns of erectile tissue which is spongy and capable of being filled with blood."¹²

The female reproductive organs :

It appears from the statement "Ithhie nābhīhiṭṭhā sirādugamī pupphānāliyāgāramī"^{12a} that the egg - producing organs of the female - the ovaries (kucchis) are held in place by ligaments within the lower part

9. Biology p. 422

10. Ibid., p. 421,

11. Ibid. p. 423.

12. Biology. p. 492.

12/a Tandula Veyāliya p. 3

of the abdominal cavity¹³ between the hips. Each of the pairs of fallopian tubes coviducts (= sirādugam) is about the size and shape of a pupphanāliyagāram (lotus stalk?).¹⁴

The reference to R̄tukāla (menstruation period) every month¹⁵ after reaching the puberty and the discharge of menstrual blood¹⁶ for three days¹⁷ each month, the closing of yoni (uterus) after 12 muhūrtas and its occurrence each month¹⁸ upto 55 years¹⁹ in Jaina Biology is suggestive that "when a girl reaches puberty there are many thousand eggs in each of her ovaries. Apparently no new ones are ever produced thereafter."²⁰

Since normally a woman ovulates thirteen times a year and but a single egg ripens each month,²¹ "only 400 or so of these eggs ever reach maturity and escape from the ovary, the rest degenerate and are absorbed.

According to modern Biology, the ovaries alternate in releasing their eggs, but the alteration is irregular and unpredictable.

Jaina Biology, explains that the egg is released into the abdominal cavity at the time of ovulation,²² whence it passes into one of two tubes called the oviducts (sirādugam)²³ or fallopian tubes. The oviducts empty directly into the upper corners of a kośa—shaped organ, the uterus or womb which houses the developing embryo until the time of birth.²⁴ This organ lies in the middle of the lower part of the abdominal

13. Tandula Veyāliya, p. 3

14. Ibid.

15. Ibid (riukāla).

16. Ibid.

"Te riukāle phuḍiyā soṇiyalavayā Vimoyamīts".

17. Ibid, Tā mañjarayaḥ strīnām māsānte, yadajasramiśram dinaṭrayam ḡravati".

18. Māsi māsi rajaḥ strīnām ajasrami ḡravati tryahām Vatsaraī dvadasādurdhvām" Ibid, p. 4, see Sthānāṅga tīkā,

19. "Paṇapannāya pareṇām yoni pamilāyae /", Ibid., p. 4.

"Yāti paṇīcāsataḥ kṣayām /, Sthānāṅgatikā vide Ibid., p. 4.

20. Biology. p. 423.

21/a Ibid.

21/b Ibid.

22. "Itthie nābhīhiṭhā sirādugam pupphanāliyāliyāgāram / tassa ya hiṭha Joni ahomuha samītiyā kosā // 9 // tassaya hiṭhā cūyassa māmjarī (jārisī) tārisā u māṁsassa" etc. "Te riukāle phuḍiyā soṇiyalavayā vimoyamīti /" Tandula Veyāliya, p. 3.

23. "Itthie nābhīhiṭhā sirādugam pupphanāliyāgāram /", Ibid.

cavity²⁵ just behind the urinary bladder. Modern Biology state that "it is about the size of a clenched fist and has thick muscular walls and a mucous lining richly supplied with blood vessels."²⁶ From the centre of its lower end (ahomuhā) a single muscular tube, the vagina,²⁷ passes to the outside of the body. The vagina²⁸ serves both as receptacle for the sperm and so must accommodate the penis, and as the birth canal when prenatal development is complete. The uterus²⁹ (yoni) terminates in a muscular ring, (cūyassa mañjari....mañsassa), i.e. "the cervix, which projects a short distance into the vagina."³⁰

Fertilization :

In the act of sexual intercourse or copulation the erect penis is inserted into the vagina, where it ejaculates about 900000³¹ sperm in the maximum, (200,000,000 sperm, according to modern Biology).³²

In one life or birth (Bhava) there may come one or two or three sperm of a male person in the minimum and 9 lakh sperm in the maximum as issue. Because there takes place the sexual activity called 'mehuṇavattie' in the heated sex-organs of the female and the male and both of them cause to combine semen (sperm) and blood (egg) into zygote in cohabitation in Yoni (cunnus) by their intercourse. Thus one or two or three sperm in the minimum and nine lakh sperm in the maximum may be ejaculated.³³

24. "Kosayaram joṇiṁ saṁpattā sakkamisiyā jayā / taiyā jivuvavāe / Ibid.

25. "Tassa ya hiṭṭhā joṇi ahomuhā saṁthiya kosā (9)" / Ibid.

26. Biology, 423 : "Tassa ya hitthā tārisā u mañsassa – Tandula Veyāliya, p. 3.

27. "Ahomuhā saṁṭṭhiyā tassa kosāya hiṭṭhā cūyassa mañjari (jārisi) tarisā itassa Tandula Veyāliya, p. 3.

28. Cūssssa mañjari (jārisi) tārisa u mañsassa / te riukāle phuḍiya .. upto taiyā jivuvavāe/". Ibid.

29. "Tassa ya hiṭṭhā joṇi ahomuhā saṁthiyā kosā", Ibid.

30. Biology, p. 423.

31. "Egajivassa egabhabhavaggahaṇenaṁ jahaṇṇenam ikko vā do vā tinni vā ukkoseṇam – sayasahass puhattam jivānam puitattāe havvāmāgacchāmī / Itthie ya purisassa ya kāmmakādāe joṇie mehuṇavattie nāmam saṁyoge samup ajjai, te duhao sjiṇeham saṁciṇāmī ..tattha nām jayaṇṇenam....havvāmāgacchāmī /", Bhagavatī 2. 5, 0.

"Jivānam parisāṁkhā lakkhapihuttam ca ukkosam" //2//, Tandula Veyāliyā, p. 4.

32. Biology, p. 424.

33. Bhagavati Sūtrā, 2, 5. 105 ; Tandula Veyāliya, see also Sutrakṛtāṅga II.5.

It appears that the sperm travel up the vagina into the uterus partly under their own power and partly by force of the muscular contraction of the walls of these organs.³⁴

Most of the sperm become lost on the journey,³⁵ but a few find their way to the openings of the oviducts and swim up them, as suggested by the statement "Egajivassa... ikko..,vā do vā tinni vā... puttattāe havvamāgacchañti."³⁶

If ovulation has occurred shortly after or before copulation, the egg which passes into the oviduct probably will be fertilized by one of the sperm.³⁷ "Only one of the millions of sperm deposited at each ejaculation fertilizes a single egg,"³⁸ according to modern Biology.

As soon as the egg has united with a sperm³⁹ it develops a fertilization membrane that prevents the entrance of others as is suggested by the fact that the unused sperm and unfertilized eggs die⁴⁰ in the oviducts or uterus.

After fertilization has occurred, the zygote, while passing down the oviduct to the uterus, begins to divide.⁴¹

34. Pañcabinñ thāñehimittī purisena saddhim asañvasamāñivi gabbham dharejjā, tamitthi duvippayadā dunnisannā sukkhappoggale addhiñtijā sukkappo,galasāñsañhe va :e sukkapoggale añupavesejjā siyodagaviyadeña vā se ayanamāñie sukkapoggale añupavesijjā iccetehim pañcāvadharejjā / Sthānāñga Sūtra V. vide Tandula Veyāliya, pp. 3-4.

35. "Bārasa ceva muhuttā uvarim viddhamsa gacchai sā u /" Tandula Veyāliya p. 4. "Rtvante striñāñ naropabhogena dvādaśa muhūrtamadhyā eva garbhābhāvāḥ tadanantaram viryavīñāśat garbhābhāvā iti /", Ibid p. 4.

36. Bhagavati Sūtra, 2. 5. 105.

37. "Kosāyāram joñim sāmpattā sukkamisiya jaiya / taiyā jivuvavāe juggā bhañiā Jīñimdehiñ /" Tandula Veyāliya, p. 3.
"Rtudinatrayānte puruṣasamānyogena apuruṣasamānyogena vā puruṣaviryēna milita yadā bhavanti tāda jivotpāde – garbhasambhūtilakṣaṇe yogyā bhavanti (comm.) Ibid, Bhagavati, 2.5.'05

38. Biology. p. 424.

39. Kosāyāram joñim sāmpattā sukkamisiya jaiyā taiya jivuvavāe juggā bhañiā Jīñimdehiñ", Tandula Veyāliya, p. 3.

40. Bārasa ceva muhuttā uvarim viddhamsa gacchai sā u / Tandula Veyāliya. p. 4. Rattakkadā u ithi lakkhapuhuttam ca bārasa muhuttā / piśamkha sayapuhuttam ca bārasavāsā u gabbhassa // Ibid., p. 5 See its co nmentary.
"Rakñena, ukañayāḥ purusaviryayuktagonyāśca ekasyāḥ striyāḥ garbhe iaghan-yataḥ eko dvau vā trayo vā utkṛṣṭatastu lakṣaṇīthakatvām...nispattim ca prāyaḥ eko dvau vā agacehataḥ śeṣāstvalpajivitattatraiva mṛyante /", Ibid.

41. Imo khalu jivo ammāpiusamānyoge māu uyan pinsukkaritam tadubhayasamāñsañham gabbhattāe vakkamai (1)

Seven⁴² or eight to ten days elapse from the time the egg is fertilized until it is implanted in the uterine wall as suggested by Jaina Biology. Until it is firmly implanted, the developing embryo is nourished by a secretion of the utrine glands known as "Kalusām Kibbisām."⁴³ (uterine milk?). At implantation the embryo consists of a cluster of several hundred cells derived by division from the original, fertilized egg⁴⁴ as indicated by the statement "Sattāham Kalalam hoim, sattāham ho abbuyam", etc.

Implantation :

It appears that the implantation of the developing embryo in the lining of the uterus is the process that involves activity on the part of both embryo and uterine lining.⁴⁵ "The embryo secretes substances which destroy a few of the cells of the lining and then penetrates at the point. This stimulates the uterine tissue to grow and surround the embryo".

Nutrition of the Embryo

As pointed out, after implantation in the uterine the embryo at first feeds on the menses of the mother and the semen of the father or both combined into an unclean, foul, (substance).⁴⁶ In other words, "The embryo continues to develop at first obtaining its nourishment by enzymatically breaking down the cells of the uterine wall immediately around it."⁴⁷ And later it absorbs with a part of its bodies the essence of whatever food the mother takes.⁴⁸ That is to say, later it continues

42. "Sattaham Kalalam hoim sattaham hoi abbuyam / Tandula Veyaliya, p. 6.

43. "Imo khalu jivo ammapiusamayoge māuyam piusukkam tam tadubhayasamśatām kalusām kibbisām tappadhmayae āharar āhārittā gabbhattāe vakkamai /" etc, Tandula Veyaliya, 1, p. 6. See Bhagavati Sūtra 1. 7 61-62.

44. "Sattaham kalalam hoim, sattānam etc." Tandula Veyaliya 2, p. 6.

45. Tassa phalabimśasarisā uppalanlovamā bhavai nābhirasaharaṇi jaṇaṇie sayā iñ nābhia padibaddhā. nāthie tie gabbho oyām aiyai aṇhayamie oyāe tie gabbhi vivadāham jāva jāva jāutti /"

46. Bioogy p. 425 Tandula Veyaliya

47. Biology p. 425

48. Sūtra Kṛtāṅga II 3.21 ; Bhagavati Sūtra 1.7 61.

"Imo khalu Jivo ammapiusamayoge māuyam pusukkam tam tadubhayasamśatām kalusām Kibbisām tappaḍha mayae āhāram āhāittā gabbhattāe Vakkamai /, Tandula Veyaliya p. 6.

to develop by extracting the nutritional essential from the blood stream⁴⁹ of the mother "via blood vessels of the placenta."⁵⁰

The new human being develops only from the cells which tie along one side hollow ball originally implanted in the uterus, like a stalk of fruit or lotus.⁵¹ "The other cells form membranes which nourish and protect the developing child eventually form part of the after-birth."⁵²

The Placenta (Mātrjivarasaharāṇī⁵³)

The placenta in the female uterus is the organ made up of the villis plus the tissues of the uterine wall in which they are embedded. By means of this placenta the developing embryo obtains nutrients,⁵⁴ and "oxygen and gets rid of carbon dioxide and metabolic wastes"⁵⁵ as explained in modern Biology.

According to Jaina Biology it appears from the statement "māu-jivarasaharāṇī puttajīvrarasaharāṇī māujivapaqibaddhā puttajīvam phuḍā" that there are many capillaries in the villi which receive blood from the embryo by way of one of the two umbilical arteries and return it to the embryo by way of the umbilical vein (nābhirasaharāṇī)⁵⁶

49. Biology p. 25.

50. Sūtrakṛtāṅga II. 3 ; Bhagavatī Sūtra 1. 7. 62

"Jām se māyā nānāvihāo navarasavigaio..... dāvvāim āhārei tao egadisenam oyamāhārei /", Tandula Veyāliya, 5, p. 9

51. "Tassa phalabim̄tasarisā uppanālovamā bhavai nābhirasaharāṇī Jāṇaṇie sayā im nābhie Paqibaddhā nābhie tie gabbho oyam aiyai aṇhayam tie oyāetie gabbho vivad̄hai Jāva Jāutti", Tandula Veyāliya 5, p. 9. Mauji varasaharāṇī Puttajīvrarasaharāṇī māujivapaqibaddhā puttajīvam paqibaddhā maujivaphuḍā tamha ciṇāi /", Ibid, 4, p. 9.

52. Biology, p. 425. Tandula Veyāliya 5, p. 9.

53. Tassa phalabim̄tasarisā uppanālovamā bhavai.....Jāṇaṇie sayā im nābhie paqibaddhā nābhie tie gabbho oyam aiyai aṇhayam tie oyāe tie gabbho vivad̄hai jāva jāutti /", Tandula Veyāliya, 5, p. 9.

54. Biology, p. 425.

55. Tandula Veyāliya 4, p. 9

56. Māujivarasaharāṇī puttajīvrarasaharāṇī māujivapaqibaddhā puttajīvam phuḍā tamhā āharei tamhā pariṇāmei avarāvi nām puttajīvapaqibaddhā māujivaphuḍā tamhā ciṇāi /", / Ibid. ; Tassa phalabim̄tasarisā uppanālovamā bhavai nābhirasaharāṇī Jāṇaṇie sayā im nābhie paqibaddhā nābhie tie gabbeo oyam aiyai aṇhayam tie oyāe tie gabbho vivad̄hai Jāva Jāuti /" Ibid, 5, p. 9.

According to Modern Biology "The bloods of the mother and foetus do not mix at all in the placenta or any other place, the blood of the foetus in the capillaries of the chorionic villi come in close contract with the mother's blood in the tissues between the villi, but they are always separated by a membrne, through which substances must diffuse or be transporated by some active energy-requiring process"⁵⁷.

It is suggestive from the statement in Jaina Biology. "The foetus transforms whatever nutritive substance it takes from the mother's body into the five sense organs, bone marrow, hair, etc.⁵⁸ and makes respiration⁵⁹ but it does not pass stool nor urine,⁶⁰ etc., like the living man "that the placenta (māṭṭjīvaraśaḥarṇī) is an important endocrine gland serving as the nutritive, respirative and excretory organ of the foetus".⁶¹

It is natural that the uterus (yoni) increases in size as the foetus grows and "by the end of nine months its mass is twenty four times as great as the beginning of pregnancy".⁶² Within the uterus the foetus assumes a characteristic foetal position with elbows, hips and knees bent, arms and legs crossed' back curved and head bowed, and turned to one side, as suggested by the statement in Jaina Biology that the foetus in the mother's womb exists like an umbrella or the side ribs of human body,⁶³ it is like hunch-backed (crooked shaped) mango (aṁbakhujjae) and also it stays standing, sitting and lying there.⁶⁴

56/a Biology p. 426.

57. Māujīvaraśaḥarṇī puttajīvaraśaḥarṇī maujīvapaṭibaddhā puttajīvāṁ phuḍā tamhā āhārei tamhā pariṇāmei avarāvi ḥāṁ puttajīvapaṭibddha Māujīvaphuḍā tamha ciṇāī" Ibid 5 p. 9.

58. Tassa phalabimṭasarisā uppalañālovamā bhavai nābhiraśaḥarṇī Jaṇaṇie sayā im babbīā paṭibaddhā nābhīc tise gabbha ḥyāṁ aīyai aṇhayaṁtic oyāē tise gabbho vivāḍḍhai jāva jāutti / Tandula Veyāliya p. 9.

59. Biology, p. 427.

60. "Jivassa ḥāṁ bhaṇte, gabbhagayassa samāṇassa atthi uccārei vā pāsavanei vā khilei vā.....no inaṭṭhe samaṭṭhe, jive ḥāṁ gabbhagae samāne jaṁ āhāraṁ āhārei tam ciṇāī soiṁdiyattāe etc. upto nahattāe /" Natthi uccārei vā Jāva soṇei vā (3)" Tandula Veyāliya p. 7.

61. Jive ḥāṁ gabbhagae samāṇe savvao āhārei savvao pariṇāmei savvao usāsei savvao usāsei savvao nisasei abhikkhaṇāṁ āhārci abhikkhaṇāṁ pariṇāmei abhikkhaṇāṁ usasei, nisāsei māujivaraśaḥarṇī puttajīvaraśaḥarṇī maujīvapaṭibaddhā. Tandula Veyāliya 4. p. 9.

62. Ibid, 3, p. 7.

63. Biology, p. 427.

64. Biology 427.

When the mother sleeps, wakes up, and becomes happy and unhappy the foetus also sleeps, wakes up and becomes happy and unhappy⁶⁵ respectively.

A child is born after the complete course of pregnancy of full nine months and seven and a half nights and days.⁶⁶ At the time of delivery if it comes out, being led first by the head or feet, it comes out in right way, if it comes out crosswise, it attains death.⁶⁷ That is to say "At birth the foetus usually is turned head doanward so that its head emerges first, but occasionally the buttocks or feet are presented first, making delivery more difficult.⁶⁸

65. "Gabbhagae samāṇe uttānae vā pāsillae vā aṁbakhujae vā acchijja vā chiṭṭhijja vā nisijja vā tuyāṭujja vā āsaijja vā upto dukkho bhavai (9) ", Bhagavatī 1.7.61. Tandula Veyāliya, 9, p. 13.

66. Ibid.

67. Ibid.

68. Bhagavatī Sūtra 1. 7. 62 ; Tandula Veyāliya, p. 13.

69. Bhagvatī, 1.7.22 Aha nām pasavaṇakālasamayāṁsisisena vā pāehim vā āgacchai samāgacchai tiriyamāgacchai viṇīghāyamāvajjai" Tandula Veyāliya 9, p. 13. (II)

70. Biology, p. 427.

(Third Section)

EMBRYONIC DEVELOPMENTS

Jaina Biology throws some light upon the division, growth and differentiation of a fertilized egg into the remarkable complex and interdependent system of organs which is the adult animal.¹ The organs are complicated and reproduced in each new individual with extreme fidelity of pattern, but many of the organs begin to function while still developing.² It appears from the study of embryonic development as revealed in Jaina Biology that the pattern of cleavage, blastula formation (hollow ball of cell-formation or first element formation) and gastrulation is seen, with various modifications,³ in all men and in all multicellular animals, according to modern Biology.⁴ The main outlines of human development can be discerned by studying the embryos of rats or pigs or even chicks or frogs.

Cleavage and Gastrulation :

In Jaina Biology it is found that the process of cleavage⁵ takes place in a single fertilized egg and helps it to develop into a many-

1. Sattāham Kalalam hoīm, sattāham hoi abbuyam, abbuya jāyae pesī, resioya ghanāmbhave (17. to pāḍhame māse karisū nām palam jayai 1 biye māse pesī samjāyae ghanā 2 taie māse mauē dohalaīn janai 3 cautthe māse māue āīngāim pīnei 4 pāīcāme māse pāīcā pīmīliyāo pāīnīm pāyām sirām ceva nīvvāttein 5 chaṭṭhe māse pittasoniyām uvaciṇei 6 sattame māse sirāsayāim 700 pāīcā pesisayāim 500 navadhamaṇio navanauīn ca romakūvasayasaḥassāim nīvattein 9900000 vinā 500 navadhamaṇio navanauīn ca romakūvasayasaḥassāim nīvattein 35000000, kesamāṁsuṇā sahā kesaunāṁsuṇā āddhuṭṭhāo romakūvakodio nīvattein 35000000, aṭṭhāo romakūvākodio nīvattein 35000000, aṭṭhame māse vittikappo havai 8" Tandula Veyāliya 2, p. 6.
2. e. g. Putrajīvarasaharaṇi (umbilical cord) functions to absorb food from the stream of mother's blood.
3. Tandula Veyāliya 2, p. 6.
"Atha daśārātrataḥ kālalatāmupayati nijesvabhāvato/daśādaśabhirdinaih Kaluṣatām sthīratām vrajalia kārmāṇā punarapi buddhīdatvaghanatā bhavati, pratimāsa māsataḥ / pīśitaviśalatā ca bahikṛta sa hi pāīcamāṁsatah // 53. Avayavasamāṁsataḥ / garbhagato hi māsataḥ / punarapicarmanā nakhāṁga-vibhāgamadhibhīgacchatī garbhagato eva māsataḥ / usaśūriramuttāmāṁgamupalabhyā muhūḥ sphuraṇām ca masato / Navadaśamāsato nijanijavirgāmanām vikṛtīstataḥ anyathā (54)" Kalyāṇakārakām, 2nd chap., vv. 53. 54, p. 27.
4. Biology, p. 430.
- 4/a. Biology, p. 430.
5. Tandula Veyāliya 2, p. 6
"Sattāham kalalam hoīm, sattāham hoi abbuyaīm /... ...upto atthame māse vittikappo havai /"

celled embryo indicating that the egg cell splits or divides.⁶ This division called mitosis in modern Biology is "accompanied by a complicated series of processes within the nucleus and cytoplasm of the cells."⁷

Blastula Formation :

As the cells undergo further division, a spherical mass) Kalalam, abbuyam, pesi, ghaṇam, palam, etc.)⁸ is formed; in the centre of it a cavity appears as it is suggested by the reference to the additional cleavages until finally the embryo consists of several hundred cells, arranged in the form of a hollow ball (arbuda or piṇḍa)^{8/a} from which differnt organs develop. At this stage the embryo is called a blastula by Modern Biology.⁹

Gastrulation :

It is suggestive from the mention of the successive stages of development of parts of the body of the embryo "Kalalam, abbuyam, pesi, ghaṇam, palam, piṇḍa, pāṇi, pāyam, siram, pitta, soṇita, sirā, pesisayām, navadhamāṇi, romakūpa, kesa, maṁsu.¹⁰" etc. that almost as soon as the single-layered blastula is formed, it begins to change into a double-layer gastrula. "In simple, isolecithal eggs gastrulation occurs by the pushing (invagination) of a section of one wall of the blastula.¹¹ "The pushed-in wall eventually meets the opposite wall so that the original blastocoel is obliterated. The new cavity of the gastrula is known as the archenteron (meaning primitive gut), because it forms the rudiment of what is to become the digestive system. This opens to the outside by the blastopore, which marks the place where the indentation for gastrulation began. The formation of the two-layered embryo is accompanied by rapid growth and division of the cells, and the resulting gastrula has about the same diameter and shape as the blastula from which it came. The outer of the two walls of the gastrula is called the ectoderm (outer skin); it eventually gives rise to the skin and nervous system. The inner wall, lining the archenteron, is known as the entoderm (inner skin); it finally becomes the digestive tract and its outgrowths—the liver, lungs and pancreas."¹²

6. Tandula Veyāliya 2, p. 6.

7. Biology, p. 431.

8. Tandula Veyāliya 2, p. 6

8/a Ibid, 2, p. 6.

"Pāṁcame māse pāṁca pimḍiyāo pāṇam payam siram ceva nivvattei"

9. Modern Biology, p. 431,

10. Tandula Veyāliya, 2, p. 6.

11. Biology, p. 431-432.

12. Biology p. 431-432

Cleavage and Gastrulation in the Human Egg

After fertilization Kalala¹³ (zygote or flat disc) is formed within seven days, next arbuda¹⁴ (*slightly hard mass or solid ball of cells or cylindrical embryo*) develops within seven days; pesis¹⁵ (tissues) are formed out of arbuda (solid ball of cells); ghana¹⁶ with four angles is next formed from pesis, i. e. blastula and so on.

That is to say, ‘the early cleavage of the human or mammalian egg resembles that of Amphioxus in forming cluster of cells called blastocyst. After this the mammalian egg differs in that the mass of cells divides into two parts—an outer, hollow sphere of cells and attached to one side of this, an inner, solid ball of cells (i.e. arbuda). The outer sphere is one of the foetal membranes, the other embryonic membranes develop from the inner, solid ball of cells. The inner ball proceeds to form a gastrula, consisting of ectoderm and entoderm. Within the inner cell mass two cavities form simultaneously. The upper one is the cavity of the amnion, lined with ectoderm. The lower one is the cavity of both the yolk and the primitive gut, lined with entoderm. Between the two cavities the cells spread out in the shape of a flat, two-layered plate, from which the embryo develops. At what is to become the posterior end of the embryo this plate connects with the outer chorion by a group of cells known as the body stalk. Into the body stalk grows the (non-functional) allantois which has developed as a tube from the rear end of the entodermal (yolk) sac. Thus we find, after about two weeks of development that the human embryo consists of a flat, two-layered disc, about 0.01 inch across, and a stalk which connects the disc with the outer chorion.’¹⁷

‘In all animals (except sponges and coelenterates) a third layer of cells, the mesoderm develops between ectoderm and entoderm.’¹⁸

Notochord (Prestage of Piṭṭhakaramḍaga backbone)

The reference to the vertebral column (Piṭṭhakaramḍaga) in Jaina Biology presupposes the notochord (prestage of Piṭṭhakaramḍaga) which is a flexible unsegmented, skeletal²⁰ (karamḍa) which extends longi-

13. Tandula Veyāliya 2 p. 6.

14. Ibid

15. Ibid

16. Ibid

17. Biology, p. 435

18. Ibid

19. Tandula Veyāliya, 16, p. 35

The short lived ‘Noto Chord’ is replaced by backbone in developed child.

20. Ibid

tudinally along the dorsal middle (piṭṭha) of all chordate embryos and is formed at the same time as the mesoderm,²¹ Biology explains that "In all Vertebrates the notochord is short-lived structure, eventually replaced by the vertebral column".²²

It seems from the absence of notochord with a proper nomenclature in Jaina Biology that the Jainācāryas did not mention it because it was a short-lived structure, eventually replaced by the vertebral column.

Development of the Nervous System

Although the two week old human embryo is a simple arbuda²³ (a simple solid ball of cells or a simple flat disc, according to Modern Biology,) the two month old embryo has nearly all its structure in rudimentary form.²⁴ The brain (Śira or matthu) and the spinal cord are among the earliest organs to appear. It is stated in Jaina Biology that in the fifth month there develop fully the five piṇḍas (two arms, two legs and head),²⁵ while śirās, dhamanis (circulatory vessels) and Snāyus (nerves) develop later on. According to Modern Biology, "All the regions of the brain are established by the fifth week of development, and a week or two later the outgrowths which will form the large cerebral hemispheres begin to grow,"²⁶

Development of Body Form :

The conversion of the two-week old flat disc (arbuda) into a roughly cylindrical embryo is accomplished by three processes. (a) the growth of the embryonic disc into peśi (blocks of muscles-māṃsakhaṇḍarūpa),²⁷ (b) the underfolding of the embryonic disc, especially at the front and rear ends into ghana (sama caturasram māṃsakhaṇḍam bhavati - square - shaped blocks of muscles)²⁸ and (c) the construction of the Ventral body wall to form the further umbilical cord (nābhi).²⁹

21. Biology, p. 437

22. Biology, p. 437. Tandula Veyāliya, I6, p. 35.

23. Tandula Veyaliya, 2, p. 6.

24. Ibid. "Bie mase peśi samjāya ghaṇā" 2

It suggests that the two-month old embryo has nearly all its structure in rudimentary form.

25. Tandula Veyāliya 2 p. 6.

26. Biology p. 447.

27. "Sattāeṁ kalalam hoiṁ. sattāham, hoi abbhuyam / abbuya jāyae peśi, pesio, ya ghanam bhave //", Tandula Veyāliya 2, p. 6.

28. Ibid.

Growth is rapid at the end of the embryonic disc and in the fifth month of the embryonic development the head, two arms and two legs bulge forward from the original embryonic five piṇḍas (areas).²⁹ That is to say, "The head region bulges forward from the original embryonic area. The tail, which even human embryos have at this stage, bulges, to a lesser extent over the posterior end. The sides of the disc grow downward, eventually to form the sides of the body. The embryo becomes elongated, because growth is more rapid at the head and tail ends than laterally."³⁰

In the first month the embryo which is about Karṣonam palam³¹ long is now recognizable as a vertebrate of some kind. It appears that "It has become cylindrical, with a relatively large head region, and with prominent gills and a tail.³² In the second month blocks of muscle (peśi) become a little solid square-like shaped (ghanā).³³ According to modern Biology, in the month-old embryo "blocks of muscle, known as somites, (i. e. peśi) are forming rapidly in the mesoderm on either side of the motochord and the beating heart is present as a large bulge on the ventral surface behind the gills. The arms and legs are still mere buds on the sides of the body."³⁴ "By the end of six weeks the embryo is about half an inch long."³⁵ "At the end of two months of growth, when the embryo is an inch long, it begins to look definitely human."³⁶ According to Jaina Biology, in the fifth month the head, two arms and two legs develop from the five piṇḍas (mass or areas) of the embryo.³⁷

But Modern Biology states that at the end of two months of growth, "The face has begun to develop, showing the rudiments of eye,

29. Tassa phalabimṭasariā uppalaṇālovamā bhavai nābhiraśaharaṇī jaṇaṇie sayā īm Nābhie paḍibaddhā nābhie tie gabbho oyam āiyai aṇhayāṁtie oyāc tie gabbho vīvaḍhai java jāuti" Tandula Veyāliya, 5, p. 9.

30. Tandula Veyāliya, 2, p. 6.

31. Biology, p. 438.

32. "Paḍhāma māse Karisuṇam palam Jayai." Tandula Veyāliya, 2, p. 6.

It is about one fifth of an inch long in the 1st month, according to Biology, p. 348.

33. Biology, p. 438.

34. Tandula Veyāliya, 2, p. 6 "Bie māse pesi sāṁjāyae ghanā"

35. Biology, p. 438.

36. Ibid.

37. Ibid.

ear and nose. The arms and legs have developed, at first stage resembling tiny paddles but by this stage the beginnings of fingers and toes are evident.”³⁸

In the six-month old embryo bile and blood get generated and in the seventh month 700 śirāś (circulatory vessels), 500 tissues of muscle and nine dhamanīs (veins or arteries ?), 9900000 hair follicles without hair and beard and 35000000 hair follicles with hair develop; in the eighth month the embryo (foetus) is almost at full term, ready to lie born.³⁹ The course of the development of body form of the foetus as described in Jaina Biology is supported by modern Biology to some extent, when it explains that most of the internal organs are well laid out so that development in the remaining seven months consists mostly of an increase in size and the completion of some of the minor details of organ formation. The embryo is about 3 inches long after three months of development, 10 inches long after five months, and 20 inches long after nine months.⁴⁰

During the third month the nails begin forming and the sex of the foetus can be distinguished. By four months the face looks quite human; by five months, hair appears on the body and head. During the sixth month, eye-brows and eye-lashes appear. After seven months the foetus resembles an old person with red and wrinkled skin. During the eighth and ninth months, fat is deposited under the skin, causing the wrinkles partially to smooth out; the limbs become rounded, the nails project at the finger-tips, the original coat of hair is shed, and the foetus is “at full term” ready to be born.”⁴¹

Here is the point to be noted that both Jaina and Modern Biologies agree to the fact that during the eighth⁴² and ninth^{42a} months there take place the full development of the foetus and it is “at full term,” ready to be born. The child is born after the gestation period of nine months

38. Pañcame mase pañca Piñqiyō Pāñjīm śirāś oeva nivvatte,
Tandula Veyaliya 2, p. 6.

39. Biology, p. 438.

40. “Chaiṭhe māse pittasoṇiyām uvaciṇei 6 sattame mase satta śirāsayām 700 Pañca pesisayām 500 navadhamapio navanuim ca romakūvasayasaḥassām nivvattei 9900000 viṇā Kesamamsuṇā saha Kesamamsuṇā addhuṭṭhāo romakuva-koḍio nivvattei 35000000. aṭṭhame māse vittikappo havai /”,
Tandula Veyaliya 3, p. 6.

41. Biology, p. 439

42. Biology, p. 439.

42/a Biology, p. 439.

and seven and half days and nights of the embryonic development.⁴³ This total gestation period or time of development, for human beings is almost equal to "the total gestation period of about 280 days for human beings, from the beginning of the last menstrual period before conception until the time of birth", as explained by modern Biology.⁴⁴

Formation of the Heart (Hiyaya)^{44/a}

Jaina Biology does not throw much light on the formation of the heart. But its reference to the generation of śoṇita (blood) in the sixth month of the growth of the foetus⁴⁵ and the development of circulatory vessels (700 Śirās and 9 dhamanis in the seventh month)⁴⁶ and to heart (hiyayam) in the adult suggests that in contrast to many⁴⁷ organs which develop in the embryo without having to function at the same time, the heart and the circulatory system function, while undergoing development.

According to Modern Biology,⁴⁸ "The heart forms first as a sample tube from the fusion of two thin-walled tubes beneath the developing head". In this early condition it is essentially like a fish heart, consisting of four chambers arranged in a series : the sinus venosus, which receives blood from the veins, the single atrium, the single ventricle, and the arterial cone, which leads to the aortic arches.⁴⁹

"In the beginning the heart is a fairly straight tube, with the atrium lying posterior to the ventricle ; but since the tube grows faster than the points to which its front and rear ends are attached it is forced to bulge out to one side. The ventricle then twists in an S-shaped curve down and in front of the atrium, coming to lie posterior and ventral to it as it does in the adult. The sinus venosus gradually becomes incorporated into the atrium as the latter grows around it, and most of the arterial cone is merged with the wall of the ventricle".⁵⁰

43. Tandula Veyāliya, 2, p. 6

43/a Bhagavatī Sūtra, 1.7.62.

44. Bhagavatī Sūtra, 1.7.62,

45. Biology, p. 440.

45/a Tandula Veyāliya 16, p. 35

46. Tandula Veyaliya 2 p. 6.

47. Ibid.

48. Ibid. 16, p. 35.

49. Biology, p. 440

50. Biology pp. 440-1.

"The embryonic heart, when it first appears is a single structure with only one of each chamber, whereas the adult heart is a double pump, with separate right and left, atria and ventricles.

The heart begins separating into four chambers at an early stage. The two ventricles are completely separated but complete separation does not occur until after birth, when the oval window between them finally closes."⁵¹

Development of the Digestive Tract :

It is suggestive from the reference to the taking of food by the foetus through diffusion,⁵² but not through mouth, that the digestive tract of the foetal child is first formed as separate foregut and hindgut by the growth and folding of the body wall.⁵³ Modern Biology explains that this body wall "cuts the foregut and hindgut off as two simple tubes from the original yolk sac. These tubes grow as the rest of the embryo grows, becoming greatly elongated."

"The mouth cavity arises as a shallow pocket of ectoderm which grows in to meet the anterior end of the foregut ; the membrane between the two ruptures and disappears during the fifth week of development. Similarly the anus is formed from an ectodermal pocket which grows in to meet the hindgut ; the membrane separating these two disappears early in the third month of development".⁵⁵

The Development of the Kidney

The development of the Kidney (taṇuyamīta ?)^{55/a} is "one of the finest and most clear cut examples of the principle of recapitulation" according to Modern Biology.⁵⁶ There is no clear mention of the formation of kidney in the embryonic development in Jaina Biology, probably because of its non-function in this stage. It is stated that the foetus does not pass urine, while developing, for whatever food - sub-

51. Biology p. 441.

52. Ibid, p. 441.

53. "Jive ṇaṇīn gabbhagae samāne no pahū muheṇam Kāvaliyam āhāram āhārittae ? savvao āhārei savvao pariṇāmei abhikkhaṇam āhārei abhikkhaṇam pariṇāmei /", Bhagavati Sūtra 17.61. ; Tandula Veyāliya 4, p. 7.

54. Biology p. 441

55. Biology, p. 441.

55/a Ibid p. 442.

56. Tandula Veyāliya, 16, p. 35

stance it absorbs from the mother's stream of blood is transformed into five sense-organs, etc. But the statement that "tanuyaṁta⁵⁷ (Kidney or small intestine?) in the adult transforms urine" presupposes the development of kidney as one of the finest and most clear cut examples of recapitulation.

The Jaina Biology's view on the non-functional kidneys suggests that "within the sub-phylum of vertebrates are three different types of kidney : 'A man develops first a non-functional pronephros, then a mesonephros, which may be functional during foetal life, and finally the permanent metanephros. The three kidneys develop one after another in both time and space, each new kidney lying posterior to the previous one'".⁵⁸

"The pronephros, which in the human embryo consists of about seven pairs of rudimentary kidney tubules, develops in the mesoderm and degenerates during the fourth week of embryonic life. From the tubules a pair of ducts grows back to the hindgut and connects with it."⁵⁹

"The tubules of the mesonephros originate during the fourth week, reach their height at the end of the seventh week, and degenerate by the sixteenth week. These tubules connect with the ducts left by degenerated phronephros, and empty into them. In the female the mesonephros and its ducts degenerate completely except for a few non-functional remnants, but in the male some of the tubules remain and are converted into the epididymides, while the ducts become the vas deferens."⁶⁰

Formation of Lungs (Phopphasaphephas) :

Jaina Biology does not throw light upon the formation of lungs in the developing foetus, for they are non-functional at this stage, although it refers to the respiration of the foetus at every moment (abhippāṇam usasei abhippāṇam nisasei)⁶¹ through the mother's organ, while developing in her womb. This fact suggests the non-

57. Biology, p. 442.

58. *Tandula Veyāliya* 16, p. 35

"Je se taṇuyaṁte teṇa pāsavane parinamei."

59. Biology, p. 443.

60. *Ibid.*

61. *Ibid.*

Tandula Veyāliya (7) p. 38.

62. *Bhagavati Sūtra* 1.7.61 ' *Tandula Veyāliya* 4, p. 9-10.

functional lungs of the foetus as explained in Modern Biology,⁶³ according to which, not much blood passes through the embryonic lungs. "In the foetus only a small amount of blood passes through the embryonic lungs, to the left atrium."⁶⁴

Thus Jain Biology reveals that reproduction involves many complex and interdependent processes, the elaboration of śukrasonīta (semen-blood)⁶⁵ which regulate the development of the gonads⁶⁶ (Jananagrānthis) of secondary sex structures⁶⁷ and the production of gametes⁶⁸ in the parents; behaviour patterns⁶⁹ which bring the parents together to release their gametes at such a time and in such a place that their union is probable⁷⁰; the union of male and female pronuclei⁷¹ followed

63. *Ecology*, p. 441

64. *Ibid.*

65. Tandula Veyāliya.

66. "Itthie ya purusassa ya Kammakaḍāe Jōnie mehuṇavattie nāmāmī samyoec samuppajjai", Bhagavatī, 2.5.105 Jōni ahomuhā sam̄thiyā kosā / tassa ya hiṭṭhā cūyassa mamjari (jārisī) tarisā māṁsassa / te riukāle phuḍiyā / Tandula Veyāliya, p. 3.

67. "Itthie nābhi hiṭṭhā sirādugām pupphanāliyāgāraim / tassa ya hiṭṭhā Jōni ahomuhā sam̄thiyā kosā," tassa ya hiṭṭhā cūyassa mamjari (jārisī) tārisā māṁsassa / te riukāle phuḍiyā soṇiyalavayā vimoyānti 10 Tandula Veyāliya, p. 3.

68. "Kosāyāram jenīm sampāttā sukkamisiyā jaiyā 1 taiyā jivuvavāe jiggā bhamiyā jinīmdehim / Tandula Veyāliya, p. 3.

69. "Pāmcāhīm ṭhānēhimīṭhi puriseṇa saddhim asaṁvasamāṇīvi gabbhām dharejjā, tam. Itthi duvvippayadā dunīsannā sukkapoggale adhiṭhijjā / sukkapoggale adhiṭhijjā / sukkapoggalasamāṇīhe va se vatthe aṁto jōnie aṇupavesejjā 2 sayām se sukkapoggale aṇupavasejjā 3 paro va se sukkapoggale aṇupavesejjā 4 siodagaviyadena vā se āyamamāṇie sukhapaggale aṇupavesejjā 5 icceteṇīm pāmcājāvadharejja" Sthānāṅga Sūtra 5 vide Tandula Veyāliya p. 3-4.

70. Itthie purisaesa ya Kammakadoe Jōnie attha nāmī mahuṇavattiyāe (va) nāmāmī samjoge samuppajjai, duhaovi siṇehām sam̄ciṇāmīti, /" Sūtrakṛtāṅga II, 2. 56., p. 98.

71. "Te rudhirabindavāḥ 'kośākāram yonīm samprāptāḥ santaḥ śukramiṣritāḥ ṣṭudinatrayāntे puruṣasamyojena apurussasamyojena vā puruṣaviryēṇa militāḥ yadā bhavanti tadā Jīvotpade garbhasambhūtilakṣṇe yogyā bhaṇīiā /' Tandula Veyāliya, p. 3.

by cleavage, gastrulation and morphogenesis⁷² and devices for the care and protection of the developing young.⁷³

72. “Imo khalu Jīva ammapiusaṁyoge māuuyaṁ piusukkam..sattāham kalalaṁ hoi
abbuyam abbuyam / abbuyā Jāyae pesio ya ghaṇam bhave / to paḍhame māse
karisūnīm palaṁ jayai / bie mūse pesi sanjāyae ghaṇā 2.....aṭṭhame māse
vittikappo havai /” Tandula Veyāliya 2, p. 6.

73. Jam se māyā nāṇavihāo nava rasavigāo tittakaḍuyakasāyimbilamahurām davvām
āhārei tao egadeseṇām oyamaharei ... - tassaphalabimṭasarisā uppalanālovamā
bhavai nābhirasaharaṇi jamanie im nābhie tie gabbo oyam aīyai aṇhayamtie
oyae tie gabbho vyaḍḍhai jāya jautti /”, Tandula Veyāliya, 5. p. 9.
“Sa tisata ...taṁgabbham, nāīsīehim nāiuṇhehim, naitittehim etc. vavagaya
roga - soga - moha - bhaya - parissamā sā join tassa gabbhassa hiām miyām
Patthām gabbha posaṇām tam dese ya Kāle ya āhāraamā hāremāni...gabbhm
parivahail /”, Kalpasūtra, 95.

SIXTH CHAPTER
THE MECHANISM OF HEREDIITY
(First Section)

The Physical Basis of Heredity¹

It appears from the study of Jaina Biology that heredity is the tendency of individuals to resemble their progenitors¹ or the tendency of like to beget like. Each new generation of organisms from two-sensed to five-sensed closely resembles their progenitors as is evidenced by the fact of the classification of animals in Jaina Biology on the basis of the senses and structures² and certain distinctive parental characteristics³ which appear frequently in successive generations of a given family tree.

Although the resemblances between parents and offsprings are close, they are usually not exact. The offsprings of a particular set of parents differ from each other and from their parents in many respects to different degrees due to Karma.⁴ "These variations are characteristics of living things,"⁵ according to Biology. Some variations are inherited ; that is, they are caused by segregation of hereditary factors

1. "Tao mayuamgā pannattā, tamjaha - māmsey 1 soṇie 2 matthulumgē 3 tao piuyaamgā pannattā, tamjaha - aṭṭhi / aṭṭhimimjā 2 kesamānsuromanāhā 3," Bhagavati Vyākhyāprajñapti, 1.7.61 ; Tandula Veyāliya, 6 p. 10.

That is to say, the individuals resemble their Progenitors structurally with some traits. Further it is stated in the Bhagavati Sūtra that the united body of the mother and father in the child lasts as long as its worldly body exists, but it comes to an end with the perish of the physique of the child at last after getting weaker and weaker, Bhagavati 1.7.61.

2. Paṇṇavānā Sūtra 1. 56-91

(Beimdiyajivapāṇṇavānā up to Pañcimdiya - manussajivapāṇṇavānā / ; see Paṇṇavānā Sutta 1.70 "Egakhurā dukhurā gaṇḍipadā saṇappadā /" Paṇṇivānā 1.70, p. 30.

3. Solidungular, biungular, multiungular animals, and animals, having toes with nails (egakhurā, dukhurā, gaṇḍipadā and saṇappadā ; Uttarādhyayānā, 36.179 ; Paṇṇavānā 1.70) have distinctive parental characteristics which appear in successive generations.

4. Kṣamābhṛḍāṇkakayormanīṣijaḍayoḥ sadrūpauṛuṣayoh, Śrimaddurgatayorbalābālavatornīrogārttayoh / Saubhāgyasubhagatvasāṅgamajuṣostulye api nītive antaram, yat tat karmanibandhanām tadapi no Jīvām vinā yuktimat//", 1st Karmigranṭha, p. 2, Devendrasūririvacita - Svopajñāṇīkopeiaḥ"

5. Biology, p. 452.

amongst the offspring. Other variations are *not inherited* but are *due to the effects of Karma⁵a or "of temperature, moisture, food, light or other factors in the environment on the development of the organism"*,⁶ as Biology explains.

The expression of inherited characters may be strongly influenced by the environment in which the individual develops as is evidenced in Jalacara (aquatic), sthalacara (terrestrial) and khecara (aerial) animals^{6/a}. "So studies of heredity consist, according to Biology in examining the traits of successive generations of organisms and inferring from the visible likeness and variations what the heredity of the genes has been".⁷

The transmission of specific characters :

In the Jaina Āgamas the Jainācāryas have touched upon the questions what parental characters⁸ are transmitted to offsprings, how specific characters⁹ are transmitted and why the offspring is of the same species as the parental organism, e. g. the human species¹⁰ or bovine species,¹¹ the equine species¹² or the Aśvattha species¹³ (*ficus religiosa*).

Jaina Biology holds the view that the foetus or rather the fertilized ovum¹⁴ develops by palingenesis¹⁵ (instead of epigenesis,¹⁶), in other

5/a 1st Karma grantha, p. 2 with Sopajñavivaraṇopetah, Devendrasūri.

6. Biology, p. 452.

6/a e.g. Jalacara (aquatic), Sthalacara (terrestrial) and Khecara (aerial) animals have the expression of their inherited characters, Pañnavanā Sutta 1. 61-91.

7. Biology, p. 452.

8. "Tao māuyamgā pañnattā, tamjähā. māmse 1 soṇie 2 n. atthulūṅgea 3 tao piuyaṁgā pañnattā, tamjähā - aṭṭhi 1 aṭṭhimimjā 2 kesamaṁsuromanahā 3 /" Bhagavati Vyākhyāprajñapti, 1.7 61. Tandula Veyaliya, 6, p. 10.

9. "Egakhurā dukhurā gandipadā and saṇapphada". These specific characters solidungularity, biungularity, multiungularity and the toes with nails of different species of animals are transmitted to their progenies, as indicated by their mode of classification. (Utt., 36. 79. ; Pañnavanā 1.70.)

10. Pañnavanā Sutta 192. (Maṇussajivapañnavanā 1.70)

11. Ibid ; 1.72 (c. oṇa, gavaya, etc.)

12. Ibid., 1.71 (assa, asstara, gheṭṭaga, etc.)

13. Ibid., 1.14. 16 (asotthe)

14. Bhagavati Vyākhyāprajñapti 1.7.61-62.

Tandula Veyaliya, 1-2, 3, 5. (Jivenpāṇi gabbhagae).

15. i.e. exact reproduction of ancestral character.

16. i.e. formation of organic germ as a new product in process of reproduction.

words all the organs are potentially present therein at the same time and unfold in a certain order,¹⁷ e. g. the fertilized ovum contains in miniature the entire structure of the organism (man).¹⁸ Skeleton (atthiya), muscle (mamsa), blood (sronita), arteries (siras?), Veins (dhamanis?), nerves (nharos = snayus), etc.^{18a} which appear separated and distinct in the full man, though from their excessive minuteness, they are undistinguishable in the fertilized ovum.¹⁹

The inheritance of specific characters is explained in Jaina Biology in accordance with this view. It assumes that the sperm-cell (sukka?) of the male parent,²⁰ contains minute elements derived from each of its organs and tissues (pitr-aangas.)^{20a}. Similarly it is suggestive that the egg (oyam)²¹ of the female parent contains minute elements derived from each of its organs and tissues (matr-aangas).^{21a} The sperm-cell (the seed in the case of a plant) and the egg cell represent in miniature every organ of the present organism and contains in potentia the whole organism that is developed out of it.²²

The fertilized ovum²³ is composed of elements which arise from the whole parental organism but it is not the developed organ²⁴ of the parents, with their idiosyncracies or acquired characters that determine or contribute the elements of the sperm-cell. Here lies the variation. The parental germ-plasm (piusukka?)²⁵ contains the whole parental organism in miniature (or in potentia) but it is independent of the

17. "Imo Khalu Jivo ammapiusamnyoge māu - uyam piusukkham tām tadubhay - samsaṭham Kalusam gabbhattāe Vakkamai (I) 'Sattāham Kalulam hoi upto aṭṭhame māse Vittikappo hāvai /'" (2) Tandula Veyāliya 1, 2. p. 6.

18. Ibid.

18/a Tandula Veyāliya, 1, 2, 3, 16.

19. Ibid., 1, 2, 3. (gabbham)

20. Imo Khalu Jivo ammapiusamnyoge māu-uyam piusukkam tām tadubhayasam-saṭṭham Kalusam gabbhattāe vakkamai (I)" etc. Tandula Veyāliya, 1-2. Sūtrakṛtāṅga II.3.21,

21/a Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya, p. 10

21. Tandula Veyāliya 1-2. (māu-uyam)

21/a Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya 6.

Tandula Veyāliya 1, 2.

22. Ibid.

23. Ibid. Bhagavatī Sūtra 1.7.61.

24. Tandula Veyāliya 16, p. 35

25. Tandula Veyāliya, 1,2.

parents' developed organs (mātṛ-āṅgas and pitṛ-āṅgas)²⁶ and is not necessarily affected by their idiosyncracies.

In fact, the parental seed is an organic whole independent of the developed parental body and its organs. According to Brahmanical Biology "In the parental (seed) an element representing a particular organ or tissue may happen (for this is accidental, daiva) to be defective or underdeveloped or otherwise abnormally characterized, and in this case the corresponding organ or tissue of the offspring will be similarly characterized."²⁷

The Śukradhārinī Śirās²⁸ (seminal nerves or ducts) contain the parental seed (piusukkām)²⁹ which is a minute organism deriving its elements from the parental organs but distinct from the latter, and independent of their peculiarities and it is the combination and characteristics of these constitutional elements of the parental seed in the reproduction tissue that determine the physiological characters and predispositions of the offspring. Germplasm (sukka ?)³⁰ is not only the representative of the "Somatic" tissues (muscular, (māmisapeśi), adipose (meda), bone (asthi) connective and nervous tissues etc. but also generates^{31/a} and is generated³² by the latter. This mutual interaction of the germ-plasm and so matic tissues (peśi) is a distinctive feature of Jaina Biology's hypothesis, the value of which should be estimated by the Biologists.

26. Tandula Veyāliya 6.

"Yaccoktaṁ yadica manamuṣyo manuṣyaḥ rabhabhāsmānna jaḍādibhyo jātāḥ piṭṭisadīśarūpā na bhavanti, tato cyate yasya yasyashi aṅgāvayāvasya bije bijabhāva upatapto bhavati tasya aṅgāvayasya vikṛtiḥ upajayāte /", Caraka, Śirās-hāṇi. 3rd pariccheda.

27. P. S. A. H., p. 235.

Sarvarya ya ca atmajānindriyāṇi tesāṁ bhāvābhāvahetīḥ dairam /"
Caraka, Sarirasthāna. 3rd pariccheda.

28. Tandula Veyāliya 16, p. 35

29. Ibid, 1-2

30. Tandula Veyāliya 1.

31. Lokaprakāśa 1.3. 9, (Rasasāgmaṁsamedo asthimajjaśukrādi dhātutām /"

"Paitṛkāṅgāni śukravikārabahulaityarthāḥ /" Tandula Veyāliya 6 (commentary)

31/a Tandula Veyāliya, 1, 2, p. 6

"Imo Khalu Jivo ammāpiusamnyoge mau-uyaṁ piusukkām tam tadubhayasām - satthām Kalusām sattāham Kalalam hoi, sattāham hoi abbuyaṁ / abbuya Jayae pesi, ... 700 pañca pesisayāim," etc.

32. Lokaprakāśa, 1.3.19.

Jaina Biology emphasizes the influence of the constituents of the food, etc.³³ on the character of the seed in the reproductive tissue especially as regards the stature of the offspring.

"The peculiar characteristics or idiosyncracies of the elements that combine to form the Bija (seed) must be regarded as a matter of chance (daiva), in other words, "the truly congenital variations are accidental."³⁴

The Development of Genetics :

As discussed above, Jaina Biology indicates that parental characters are transmitted through both the sperm and egg.³⁵ It is suggestive from this fact that inheritance is governed by units (factors) present in the cells of each individual as is evidenced by the embryonic development³⁶ and the transmission of Partental Characters or traits.³⁷

This view on the development of genetics as implied in Jaina Biology is explained by Modern Biology in this manner that there are two such factors (embryonic characters). "In the adult plant which segregated in the formation of pollen or eggs so that there was only one of each kind of factor in the egg or sperm."³⁸ This contention of Biology on the

33. Tām gabbham nāīshēhim, nāīuṇhēhim, nāītittehim, naikāḍuehim, naikasāehim, nāī-āmvillehim, nāīmahurehim, nāīnidhēhim, nāīlukkhehim, nāīsukkhehim, ..bhoyaṇācchāyaṇāgāndhamallehim, vavagaya-roga-soga-moha-bhaya-parissamā sā Jām tassa gabbhassa hiām miyām patthām /gabbhaposāmām tām dese ya kāle ya āhāramāhāremāṇī" etc, Kalpasūtra, 95, p. 85. "Tāndutaktam Varṣāsu lavaṇamāṇītām śāradi Jalaṁ gopayaśca hemante / śisire cāmalakacaraso, ghṛtam vasante guḍaścā ante", Ibid., p. 85 Subodhikā" Yaduktām Vāgbhāṭṭe- Vātalaiśca bhaved-garbhāḥ kubjāndhajādavāmanāḥ / pittalaiḥ khalatīḥ puṇghā, śvītri pāṇḍuḥ Kaphātābhīḥ / Tathā atilavaṇām netraharam, atiśitām mārutām prakopayati / atyuṣṇī harati balām, ātikamām Jīvitām harati "2", Ibid, p. 86.

34. Positive Sciences of the Ancient Hindus, p. 237 add here.

35. Bhagavatī Sūtra 1.7.61 ; Tāndula Veyāliya 1, 2. "Imo Khulu Jivo ammāpiusa- myoge mau-uyām piusukkām sāṁsaṭṭham...gabbhattāc vakkamai etc" ..- up to vittikappo havai /" Māu-aṅgā - māīse mathulāmīge peo - aṅgā - aṭṭhi, aṭṭhi- mīmja etc.) Tāndula Veyāliya 6 ;

36. Tāndula Veyāliya 1, 2, 6

37. Tao māu-aṅgā paṇṇattā, tāmjhā - māīse 1 soṇie 2 matthulāmīge' 3..... Tao piuarīgā paṇṇattā, tāmjhā - aṭṭhi / aṭṭhimīmja 2 kesamāṁsuromanahā 3", Tāndula Veyāliya 6 ; Bhagavatī Sūtra 1.7.61-61. Matthulūmīeti mastakābhejjakām anye tvāhuḥ - Medālphippisādīḥ mastulāmīgamiti 3 Pait̄kuṇgāusukravikārabahu- lāmītyarthāḥ prajñāptāni ? / Śukraṇonītayoh samavikārārūpatvāt mātāpitroḥ sādhāraṇānīti /, Tāndula Veyāliya 6. p. 10 (comm entary).

38. Biology, p. 453.

development of genetics is implied in the Jaina view when the details of cell division and fertilization are known from the evidences furnished by Jaina Biology.³⁹ It should be noted in this connection that the growth of each plant or animal is due to cell divisions plus increases in the size of the cells which comprise the organism. "This division of cells is an extremely regular process called mitosis⁴⁰" in modern Biology.

The Determination of Sex

Jaina Biology explains that the relative predominance of the sperm (Sukka?) and germ cells (Ojaṁ?) in the fertilized ovum (gabbhagaya jīva) is a factor which influences the sexual character of the resulting offspring. Excess of the sperm-cell produces the male, that of the germ-cell—the female. If the sperm-cell and germ-cell are equal, a neuter is born.

The Jaina view on the determination of the sex is further stated that it depends in part on a periodicity to which the life-history of the ovum in the female parent is conceived to be subject—a law under which the fertilization of the ovum on the fourth day after the menstrual discharge, or on the alternate (even) days succeeding is favourable to the foetus developing the male sexual character, and on the fifth, seventh and alternate following days to the foetus assuming the female sex.⁴²

It seems from the study of garbhapoṣaṇa (nourishment of embryo) by the mother that there is an influence of nutrition on the ovum especially as regards the stature of the resulting offspring.⁴³

The Jaina view on the determination of the sex finds support in Brahmanical Biology in the same manner that it emphasizes the relative predominance of the sperm and the germ cells in the fertilized ovum.

39. Tandula Veyāliya, 1-2.

40. Biology p. 453.

41. "Appam sukkam bahum uuyam. itthi tattha jayai / appam uyan bahum sukkam, puriso tattha jayai 2(1) (22) duṇhampi rattasukkāṇam, tullabhāve napuṁsao 3 itthiuyasamāoge, bimbam tattha jayai" 4 (2) (23) Tandula Veyāliya, p. 13.

42. "Rtusu dvādaśa niṣāḥ, pūrvāstisro atra ninditāḥ / ekadaśi ca yugmāsu, syātputro anyāsu kanyākā // 4 // " Tandula Veyāliya, Ṭikā, p. 4.

43. Taenam sā Tisalā . . . tam gabbham nāisiehim, nāiunhehim, . . . sā jaṁ tassa gabbhassa hiaṁ miyāṁ pattham gabbhaposanam tam dese ya kāle ya āhāra—māhāremaṇī, etc. suhāṁ parivahai /" Kalpasūtra 95. pp. 86-87 with Subodhikāṇikā.

"Excess of the sperm-cell produces the male, that of the germ-cell the female."⁴⁴ "The sexual character of the offspring depends in part on a periodicity to which the life-history of the ovum in the female parent is conceived to be subject - a law of alternate rhythmic change (not unlike what we now know to regulate the development of several orders of bacteria or unicellular organisms), a law under which the fertilisation of the ovum on the fourth day after the menstrual discharge, or on the alternate days succeeding, is favourable to the foetus developing the male sexual character, and on the fifth, seventh, and alternate following days to the foetus assuming the female sex."⁴⁵

The Prayogachintāmani states that the latter occurs on even days and the former on odd days. Influence of nutrition on the ovum, especially as regards the sex, stature and colour-pigment of the resulting offspring is emphasized in this way that "in general way ghee and milk for the male, oil and beans for the female parent are favourable to the bija."⁴⁶

The Jaina view on the determination of sex is indirectly supported genetically by Modern Biology in the following manner. "In man and perhaps in other mammals maleness is determined in large part by the presence of Y chromosome. An individual who has the XXY constitution is a nearly normal male in his external appearance, though with underdeveloped gonads. An individual with one X but no Y chromosome has the appearance of an immature female".⁴⁹

"Eggs contain one X chromosome; half the sperm have an X chromosome, the other half have a Y. Fertilization of an X-bearing egg by an X-bearing sperm results in an XX, female, zygote. The fertilization of an X-bearing egg by a Y-bearing sperm results in an

44. "Ādhikye retasāḥ putraḥ, kanyā syat ārttave adhike //, Caraka, Sarirasthāna, vide Positive Sciences of the Ancient Hindus, 239.

45. "Snānat prabṝti yugmeṣu ahasu saṅgametāṁ putrakāmau tau ayugmeṣu duhitī- kāmau , etc. Ibid. Vide Positive Sciences of the Ancient Hindus pp 236, 38.

46. Vide the Positive Sciences of the Ancient Hindus, p. 237.

47. "Upācarecca madhurauṣadhasāmīkṛtābhyāṁ ghṛtakṣīrābhyāṁ puruṣāṁ striyantu tailamāśābhyāṁ /." Caraka, Sarirasthāna, vide the Positive Sciences of Ancient Hindus, pp. 237-38.

48. Biology, p. 474.

49. Ibid.

XY, male, zygote. Since there are equal numbers of X- and Y-bearing sperm, about equal numbers of each sex are born.”^{49/a} “This XY mechanism of sex determination is believed to operate in all species of animals and plants with separate sexes.”⁵⁰ “In birds and butterflies (Lepidopters) the mechanism is reversed; males are XX and females are XY. Sex chromosomes have been detected in some plants, notably in the straw-berries, and probably exist in other plants with separate sexes. The members of many species have the organs of both sexes present in each individual. In such organisms, termed ‘hermaphroditic,’ if animals and monoecious if plants, sex chromosomes have not been found”.⁵¹

These hermaphroditic animal monoecious plants without having chromosomes may be compared with the Saṁmurechima prāṇis (animals) and Vanaspatis (plants) without having sperms and egg, and pollens and ovules respectively.

49/a Ibid.

50. Ibid

51. Ibid.

(Second Section)

INHERITANCE IN MAN

Some of the phenomena in human inheritance have been observed by the Jainācāryas. Some principles apply to the inheritance of human traits as are suggested by the study of Jaina Biology¹ and Daśadaśās (ten stages of life).²

The Inheritance of Physical Traits :

The study of some evidences in the Jaina works suggests that the development of each organ of the body is regulated by a large number of genes³ (units of inheritance). The age at which a particular gene expresses itself phenotypically may vary widely as is suggested by ten daśās (stages)⁴ of human life.

Most characteristics⁵ develop long before birth but some, such as, hair and eye colour, etc.⁶ may not appear until shortly after birth. Some

1. The child inherits muscles, blood, brain matter from the mother and bone (i.e. skeleton), marrow of the bone, hair on head, beard, hair on body and nail from the father. Besides it inherits five sense-organs, circulatory and respiratory systems, excretory system, endocrine system, digestive system, nervous system, etc. See Tandula Veyāliya 1, 2, 3, 16.
2. “Āuso ; evam Jāyassa Jāmtussa kāmeṇa dasa dasā evamāljjamāti tamjhā - Bālā 1 Kiḍā 2 māmā 3 balā ya 4 paṇṇā ya 5 hāyāni 6 pavaṇca 7 pabbhāra 8 mummuhī 9 sayāni ya dasamā ya 10 Kaladā (1) (31 ”. Tandula Veyāliya p. 15.
3. Biology, p. 501 “gene applies to any hereditary unit that can undergo mutation and be detected by the change it produces in the pheno type of the organism,” Ibid, p. 485.
4. Tandula Veyāliya pp. 15-16. ‘Jāyamittassa, Jāmtussa, Jā sā paṭhamiyā dasā / na attha suhām dukkham vā, nahie jānamāti bālayā (1) (32) Biiyām ca dasamā patto, nāñākilāhim kiḍai / na ya se kāmabhogeṣu, tlvvā uppajjaī rai (2)(33). Taiyām ya dasamā patto. pañkāmaguṇe naro / samattho bhūmijum bhoe, jai se atthi gharo dhuvā. (3) (34) Cauthī u bala nāma, Jām naro dasamassio / samattho balam dariseum, Jai bhave nuruvaddavo (4) (35) pañcamis dasamā patto, āñupuvvīte Jo naro / samattho’ aṭṭho vicitēum, kudumbarām cābhigacchai (5) (36) Chaṭṭhio hāyāni nāmā, Jām naro dasamassio / virajjai u kāmesum, īñdiesu ya hāyai (6) (37) sattamī ya pavameā o, Jām naro dasamassio / nice-hubhai cikkaṇām khelam, khāsāi ya khaṇe khaṇe (7) (38) sañkuiyavalicāmō. sañpatto aṭṭhamidasamā / nāriñām ca anīṭho ya, Jarāe pariñāmino / Jarāghare viñassamāte, jivo vasai akāmao (9) (40) hiñabhiññasaro diño, vivario vicittao / dubbalo dukhio suyaī, sañpattoo dasamīn dasamā” (10) (41) Tandula Veyāliya pp. 15-16.
5. Tandula Veyāliya 1, 2, 3, 6.
6. Ibid, p. 15 (Prāhama daśā)

such as amaurotic idiocy (bālatva or mandatva)⁷ becomes evident in early childhood and still others, such as, cough, phlegm, bending of the body, feeble sense-organs, etc.⁸ develop only after the individual has reached maturity.

The Inheritance of Mental Abilities :

“The inheritance of mental ability or intelligence is one of the most important, yet one of the most difficult problems of human genetics”⁹ as indicated by Biology. The reference to the fact in the Jaina works that the mental capacities of people form a continuous series from idiot (manda or Jaḍa) to genius (manīṣī)¹⁰ suggests that “intelligence is inherited by a system of polygenes^{10a} brought about by Karma,¹¹ other evidence¹² substantiates this hypothesis. According to modern Biology, “The inheritance of feeble-mindedness (māḍatā or Jaḍatā or bālatva) is due to a single recessive gene.”¹³

It is now evident that the inheritance of mental defect is much more complex. Feeble-mindedness may be caused by diseases,¹⁴ or by other environmental factors,¹⁵ but “the majority of cases are due to inheritance.”

7. Ibid, p. 15 (Prathāmā and Tṛīyadasā)
8. Ibid, p. 16 (hāyanī – 6th daśā), Pavaṁca (7th daśā), Saṁkulyavalicammo 8th daśā), etc.
9. Biology, p. 504.
10. “Māṇīsimanda”, 1st Karmagrantha with sopajñāṭikā by Devendrasūri, p. 2.
- 10a The term ‘polygenic inheritance’ or multiple factor inheritance is applied when two or more independent pairs of genes affect the same character in the same way and in an additive fashion, e.g. skin colour in man, Biology, p. 47.
11. Māṇīṣi jaḍayo..... Karmanibandhanam.
Karmagrantha I, with Sopajñāṭikā Devendra Sūri, p. 2.
12. “Kṣaṁbhṛdrankakayormaniṣijadayoḥ, sadrūpanirūpayoḥ, śrīmadurgatayorbalabālavatornirogarogāṛttayoḥ // Saubhāgyāsubhagatvasaṅgamajuṣostulye ‘api hṛīve yat tat karmanibandhanāṁ tadapi no antaram, Jivāṁ vinā yuktimat /” Ibid. (comm.) Polygenic Inheritance : Many human characters – height, body, form, intelligence and skin colour etc.... cannot be separated into distinct alternate classes, and are not inherited by a single pair of genes, Biology p. 470.
13. Biology, p. 504.
14. Biology, p. 504 ; “Micchabhavaṁtarakevalagelannapamādamatiñā nāso / ‘Ahā kimatthāñ nāsatī kiṁjivātötayāṁ bhiṇṇām / (537), Viśeṣāvaśyakabhāṣya, gāthā (53 L. D. Series ; old Ed. (540), p. 113 “Aparasya tu glānāvasthāyāṁ anyasya kimāpunaḥ pramāḍādinā iha bhave api tasya (śrutajñānasya) nāso bhavatī /” Ibid Vṛtti on 540, p. 291. i. e. śrutajñāna gets destroyed because of feeble mindedness caused by diseases.
15. Viśeṣāvaśyakabhāṣya, 537.

According to Biology, "special abilities-musical, artistic, mechanical and mathematical have a heredity basis and their inheritance is separate from that of general intelligence."¹⁶

Heredity and environment :

It is suggestive from the study of the rise of Karma, etc. from the points of view of dravya (substance), kṣetra (locus), kāla (time), bhava (life of birth) and bhāva (condition)¹⁷ that both physical and mental traits are the result of the interplay of both genetic (i. e. from the aspect of dravya) and environmental factors (i.e., from the aspects of Kṣetra, kāla, bhava and bhāva.)

According to Biology, "A few genes, such as, those that determine the blood groups, produce their effect regardless of the environment. The expression of other genes may be markedly affected by altered environment."¹⁸ The upper limit of a person's mental ability is determined genetically as is indicated in the later stages (daśās)¹⁹ of his life but how fully he develops inherited abilities is determined by environmental influences²⁰ by his training and experience.

It is easy to understand why the offspring of intelligent parents are sometimes less intelligent (māṇḍa) than either parent because of past Karma.²¹ Biology explains this point in this way that "Since the co-ordinate action of many pairs of genes is involved in intelligence the fortuitous combination of those which produced the intelligent parents be broken up by genic segregation. Conversely, the chance recombination of favourable genes may produce a brilliant child from average parents, (but geniuses are never produced by feeble-minded parents).²²

16. Biology, p. 504.
17. "Udayakkhayakkhayovasamovasamā Jaṁ ca kammaṇo bhanītā / Devvāṁ Khetāṁ Kālāṁ bhavaṁ bhāvam ca saṁppappa", Viśeṣāvaśyakabhaśya, gāthā 572, L.D. Series, p. 119.
18. Biology, p. 506.
19. Saṁkuiyavalicammo, sampatto aṭṭhamidasam / nāriṇam ca anīṭho ya, Jarāe pariṇāmio" (8) (39) navamīnmuhi nāma, Jaṁ naro dasamassio / Jarāghare viṇassamīte, jivo vasai akāmao / (9) (40) hina bhinnasaro dīṇo, vivavio vicittao / dubbalo dukkho suyaī, saṁpatto dasamī dasamā (10) (41)" Tandula Veyaliyā, p. 16.
20. "Khettaṁ Kālāṁ bhavaṁ bhāvam ca saṁppappā /", Vbha. Gā 572, p. 119;
21. First Karmagrantha with auto-commentary, Devendrasūri, p. 2.
"Kṣamābhṛdaṇkakayormaniṣijaḍayoh.....Karmanibandhanāṁ /"
22. Biology, p. 506.

SEVENTH CHAPTER

EVOLUTION OF ORGANIC LIFE IN JAINA BIOLOGY.

(First Section)

PRINCIPLES OF ORGANIC EVOLUTION IN JAINA BIOLOGY.

The Jaina concept of organic evolution may be formed on the basis of detailed comparisons of the structures (saṁṭhāṇas)¹ of living forms,² on the sequence of appearance and extinction of species³ in past ages, on the physiologic and biochemical similarities⁴ and differences⁵ between species as revealed in Jaina Biology and "on the analyses of the genetic constitution of present plants and animals"⁶.

According to modern Biology, "The term 'evolution' means an unfolding or unrolling - a gradual, orderly change from one condition to another".⁷ "The principle of organic evolution states that all the various plants and animals existing at the present time have descended

1. Ekendriyajiva up to pañcendriyajiva have many types of shapes by which they may be distinguished. 'Saṁṭhāṇadēsō vāvi, vihāṇāīm sahassaso.' Uttarādhyayana Sūtra 36, 88, 91, 105, 116, 125, 135, 144, 154, 169, 178, 193, 202. e.g. Egakhurā, dukhurā ceva, gamḍipayā sanappayā Hayamāī Goṇamāī, gayamāī sihamāīṇo". Uttarādhyayana Sūtra, 36.180 ; see Pañnavanā, 1.70.
2. Uttarādhyayana Sūtra 36. 68-197 ; Pañnavanā Sutta 1. 8. 147 (Saṁsārasaṁjāvanā jīva pañnavanā).
3. E.g. Sthalacarajivas (terrestrial animals) are beginningless (anādiya) and endless (apajjavasiya) with regard to Santati (series of issues-generations, but they have a beginning and an end with regard to duration (ṭhiti) of an individual soul as Sthalacara during life, i.e. birth and death because of the sequence of their appearance and extinction in past ages.
"Saṁtaīm pappa nāīyā, apajjavasiyāvi ya / Thiīm paḍucca sāīyā, sapajjavasiyā ya // " Uttarādhyayana Sūtra 36. 183.
4. E.g. "Egakhurā, dukhurā ceva, gamḍipayā sanappayā Hayamāī, goṇamāī, gayamāī sihamāīṇo" Uttarādhyayana Sūtra 36.180. Pañnavanā Sutta, 1. 70-74 (Tirikkhaṇoṇiya pañnavanā) See the second section "The living evidence for evolution"
5. Ibid.,
6. Biology, p. 512.
"Shāvaraṁ purakkhāyām savve pāṇā savve bhutā savve jīvā savve sattā nāṇāvi-hajonyā nāṇāvihāsaṁbhavā nāṇāvihāvukkamā sarirajoṇiyā sarirasaṁbhavā sari rasasaṁbhavā sarīravukkamā sarīrahārā kammovagā kammaniyāṇā kāmmagatiyā kammatihiya kammaṇā ceva vippariyāsamuveṇti / se evamāyāṇaha se evamāyāṇitta aharagutte sahie samie sayā jae Hibemi samie" suz. 362 Sūtrakṛtangā II 3.62.
7. Ibid.

from simpler organism by gradual modifications which have accumulated in successive generations⁸."

It appears from the study of Jaina Biology that the Jainācāryas have worked out a theory of a sort of gradual evolving life-forms on the basis of sense-organs⁹ from the micro-organisms (nigodas)¹⁰ - one-sensed up to the five-sensed animals - men,¹² according to their metaphysical belief that the *Karmaprakrti* strives to change from the simple and imperfect to the more complex and perfect as a result of modifications of karmas^{12a} accumulated in successive births in past ages.

There are infinite micro-organisms¹³ (nigodajivas) which do not attain the state of life of movable animals (trasādis), i.e. they do not evolve into movable beings or undergo gradual, orderly change. They are born and die, in their inclusion bodies (sādhāraṇaśarīras); again they continue their life in the same stage.¹⁴

It is further stated that whatever number of beings from amongst the number of Samvayahārārāśis (from gross one-sensed beings up to five-sensed beings-men) attains perfection, their equal number of beings from amongst beginningless fine plant-lives evolves into samvayahārārāśis (gross one-sensed movable beings up to five-sensed beings).¹⁵

Here it is suggestive from this statement that the process of evolution of organisms has not ceased, "but is occurring more rapidly to-day than in many of the past ages according to modern Biology.

8. Ibid.
9. Uttarādhyayana Sūtra 36. 68-197. ; Paññavānā Sutta 1. 19-55 (Egimdiyajivapaññavānā) up to 1-92. 138 (Parīcendiyamanussajivapaññavānā)
10. Bhagavati Sūtra 25. 5. 749 ; Jivābhigama Sūtra pp. 997 ; Paññavānā Sutta 1.55. 102 ; Lokaprakāśa 1-4th Saṅga, v. 32 ; Nigodasaṭṭriṇīśikā, Gommaṭasara (Jiva), 73.
11. Uttarādhyayana Sūtra 36, 68 ff., Paññavānā Sutta 1.1-55.
12. Uttarādhyayana Sūtra 36. 194-7 ; Paññavānā Sutta 1.92.138
- 12/a Sūtrakṛtaṅga II. 3.62 "Savve pāṇā savve bhūta... . . .ceva vippariyāsaṁuvaiṇti"
13. Atthi aṇāmītā jivā, jehim na patto tasai pariṇāmo. Uppajjāmīti cayamīti ya, punavi tattheva tattheva." Bṛhatsaṅgrahaṇī, v. 277; see also Visesāṇavati, 'Te viṇāmītāmītā i goavāsāmī aṇuhivānti," vide Lokaprakāśa 1.4.67.
14. Bṛhatsaṅgrahaṇī v. 277.
15. Sijjhanti jattiya kira iha saṁvayahārāśi majjāo / Inti aṇāivānassaimajjāo tattīa tāmmī // 58 /, Prajñāpanāvṛtti, vide Lokaprakāśa, 1.4.58, p. 328.
16. Biology, p. 512.

The Jainācārayas believe that organisms are guided through their lives by an innate and mysterious force called paryāpti¹⁷ which enables them to over-come handicaps in their metabolism and environment.

These adaptations¹⁸ once made are transmitted from generation to generation. "But acquired characteristics cannot be inherited, for such characteristics are in the body-cells only, whereas an inherited trait is transmitted by the gametes – the eggs and sperm"¹⁹, as it is suggested by the statement that the child in the mother's womb inherits (receives) flesh, blood and brain matter from the limbs of the mother and bone, marrow, hair, beard and hair on the body and nail from the limbs of the father,²⁰ the combined body of the parents in the child (first as gametes, next as developed body) lasts as long as its worldly body exists²¹

The study of Jaina Biology indicates that variation²² is the characteristic of every group of animals and plants, and organisms may differ in many ways.²³ Animals and plants exhibit many variations which are neither a help nor a hindrance to them; these will be transmitted to succeeding generations.²⁴ There may be geographic or genetic or ecologic isolation of incipient species to prevent interbreeding.

Modern Biology explains that variations arising from changes in the genes or chromosomes – called mutations – are the raw materials for evolution by natural selection. Obviously, then, evolution cannot take

17. See the 1st section of the 1st chapter for paryāpti and its function.
18. Beings adapt themselves to different environment in their life's struggle for existence as it is found in the case of Sthalacara (terrestrial), Jālacara (aqueous) and khecara (aerial) prāṇis (animals). See Sūtrakṛtāṅga, Śrutasandha II, Adhyayana 3, Bhagavatī Sūtra 7.3.275. Pañṇavānā Sutta, Sthāapadām; Jivābhigama Sūtra 1. 34-36; Tarkarabasyadipikā, v. 49 (Jainamatam), Tīkā by Guṇaratna.
19. Biology, p. 514.
20. Bhagavatī Sūtra, 1.7.61. Tandula Veyāliya, 6.
‘Tao māu-āingā paṇṇattā, tamjāhā, māmse 1 soṇie 2 matthulume 3 tao piu-āmṣā paṇṇattā, tamjāhā-aṭṭhi 1, aṭṭhimiṁja 2 kesamāṁsuromaṇahā 1’.
21. Bhagavatī Sūtra 1. 7.61.
22. See the chapters on the classifications of plants and animals and their reproductions – 2nd chapter and 3rd chapter. The Evolution of Plant Reproduction and Reproduction (5th chapter). Variations are based on structure, sense-organs, habitat (sthala jala, nabha etc.), reproduction, etc.
23. Ibid.
24. See the 6th chapter on the Mechanism of Heredity.

place without mutations, and although natural selection does not create new characteristics, it plays an important part in determining which of them shall survive".²⁵ Truly speaking, "The evolution of new species involves both mutation and natural selection".²⁶

The origin of life :

Now the question is how the ultimate origin of life on this planet took place. The Jainācāryas do not believe in the origin of life as modern Biology advocates. Plant life²⁷ and animal life²⁸ are, according to them, beginningless (anādi) and endless (aparyavasiū) with regard to santati (series of species).²⁹ But Jaina Biology conceives the different states of birth of the world of life: plants and animals in some sort of evolutionary relationship. So according to its concept, the first living organisms are the infinite Nigodas (micro-organisms),³⁰ continuing their life in inclusion bodies (sādhāraṇa śiriras)³¹ like huge colonies of viruses, but most of them do not attain the state of movable animals.

It appears that they exist in an atmosphere, presumably obtaining common energy and common respiration by the fermentation of certain of the organic substances (i. e. molecules of the common body), as it is suggested by the statement that "common differentia of these Nigodas (micro-organisms) is said to be the common food and common respiration."³³

These heterotrophs could survive only as long as the supply of organic molecules accumulated from the past lasted, as is implied by the words that "in that common inclusion body when one Nigoda (micro-organism) dies, there is the death of infinite Nigodas

25. Biology p. 515.

26. Ibid, p. 517.

27. Uttarādhyayana Sūtra 36.1.1. "Saṁtaim pappa nāyā, apajjavasiyāvi ya / Ṭhīm puḍucca sāiyā, sapajjavasiyāvi ya //"

28. Uttarādhyayana Sūtra 36, 131, 140, 150, 159, 174, 183, 189, 198.

29. Ibid.

30. "Atthi aṇṇīta jīva, jol iñ na patto tasaiparināmo," Bṛhatsamgrahaṇi, v. 277, p. 2.

31. Gommaṭasāra, Jivakāṇḍa 191.

32. Bṛhat Samgrahaṇi, v. 277.

33. "Sāhāraṇamāhāro sāhāraṇamāṇapāṇagahaṇām ca / Sāhāraṇajīvāṇām sāhāraṇalak-khaṇām bhaṇiyām //", Gommaṭasāra, 192 (Jivakāṇḍa).

(micro-organisms) (with it), (while) when one Nigoda is born, there is the birth of infinite Nigodas there.”³⁴

In the next stage it is suggestive that before the supply of organic substances was exhausted, the heterotrops (some sūkṣma Nigodas) evolve further and become autotrophs³⁵ (bacteria saṃvavahārārāśis), which are able to make their own organic molecules by chemosynthesis or photosynthesis³⁶ as is suggested by the reference to sevāla, and green plants in summer that many uṣṇayonika beings (plant bacteria?) get generated as plant-bodied beings (vanaspatikāyikas) in certain numbers, and they increase and decrease also in certain numbers and they are born again, for this reason many plants, having leaves, flowers and fruits, remain (or look) green and shining in summer season.³⁷

Modern Biology explains this evolution of heterotrops into autotrophs in this manner: “An organism might acquire by successive mutations, the enzymes needed to synthesize complex from simple substances, in reverse order to the sequence in which they are normally used.”³⁸

“When, by other series of mutations, the organism was finally able to synthesize all of its requirements from simple inorganic substances, as the green plants can, it would be an autotroph”.³⁹ “And once the first simple autotrophs had evolved, the way was clear for the evolution of the vast variety of green plants, bacteria, molds and animals that inhabit the world”.⁴⁰

It is suggestive from these considerations of the world of life that the origin of life, as an orderly natural event on this plan was possible, although the Jainācāryas have worked out a theory of a sort of gradual evolving life-forms according to their metaphysical belief that all life

34. “Jatthekka marai jivo tattha du maraṇam have aṇaītāṇam / Vakkamī jattha ekko vakkamaṇam tatthaṇamtāṇam,” Ibid, 193.

35. “Sijjhanti jattiyā kira iha saṃvavahārārāśimjjāo Inti aṇāīvaṇassaimājjāo tattiyā tammi /” Prajñapanāvṛtti, vide Lokaprakāśa, 4.50, p. 328.

36. Green algae, etc. can make their photosynthesis, sevāla, (algae), etc., are mentioned in the Sūtrakṛtāṅga II. 3. 54.

37. Bhagavatī Sūtra 7.3.275.

38. Biology, p. 522.

39. Ibid, p. 523.

40. Biology, p. 523.

gave rise to a variety of forms which were able to take advantage of the different habitats available.⁴⁵

Some plants⁴⁶ and terrestrial animals⁴⁷ as mentioned in Jaina Biology are indigeneous, but those of every other parts of India resemble every other species and those of other places resemble some other place's species. It may be inferred from this fact that organisms from the neighbouring parts might have migrated or were carried to the new land and subsequently evolved into new species. It should be noted that there is no indigeneous camel⁴⁸ in Bengal, even though there are tigers, etc. in the Sunderbans in Bengal, ideally suited for such creatures, because this animal (camel) cannot survive being exposed to Bengal's climatic conditions.

There are many facts about the present distribution of animals and plants as described in Jaina Biology which can be explained only by their evolutionary history. Allegators⁴⁹ are found only in rivers of some parts of India. Some plants and trees grow only in some parts of India, e. g. cāpāvamśa⁵⁰ (a kind of bamboo) found in Assam and Bengal. There are described many kinds of bamboos⁵¹ and allegators⁵² in Jaina Biology. It seems that because the bamboo plants and allegators have been separated respectively for several thousand years in their respective habitats, they have followed separate evolutionary pathways, and are slightly different, but they are still closely related species of the same genera⁵³ in their respective taxonomy.

According to modern Biology, one of the basic tenets of Biogeography is that "each species of animals and plants originated only once."⁵⁴ From its headquarters each species probably spread out

45. Biology, p. 548.

46. See the second chapter : "Types of Plants".

47. See the 3rd chapter "Classification of Animals".

48. Uttā. (Paññavaṇā 1. 72).

49. Gāhā (Paññavaṇā 1. 65).

50. Cāvavamśa (Paññavaṇā 1. 46)

51. Vamśe velū kaṇṭe kamkāvamśe ya cāvavamśe ya /" Udae Kuḍac vimae Kam-dāvelū ya Kaltāṇa // Paññavaṇā 1. 46.34.

52. Paññavaṇā 1. 65. "Dili vedhalā muddhayā pulagā sīmāgārā /" Setām gāhā

53. Biology, p. 548.

54. Biology, p. 548

until halted by a barrier of some kind - physical, such as, an ocean, a river, a desert, a mountain and environmental, such as, an unfavourable climate or biologic, such as, absence of food or presence of enemy organizations which prey upon it or compete with it for food or shelter.”⁵⁵

The question why certain animals and plants are present in one region but are excluded from another in which they are well adapted to survive (and in which they flourish when introduced by man) can be explained only by their evolutionary history.

55. Ibid, p. 549. The Sūtrakṛtāṅga II. 3 (knowledge of food) suggests that there is a biologic barrier for plants and animals to survive because of absence of food or presence of enemy organizations which prey upon a species or compete with it for food or shelter.

(Third Section)

PRINCIPLES OF ECOLOGY

A close study of the world of life-plants and animals as presented in Jaina Biology reveals that there is a remarkable fitness of the organism for the place (*ṭhāṇa*)¹ in which it lives, e.g. water for aquatic animals, land for terrestrial animals and air for aerial animals² as indicated by their classifications and habitats. It is suggestive from this fact of fitness of organisms for the habitats in which they live that this fitness of their structure, of function, even of behaviour pattern, has arisen in course of evolution by natural selection³ as explained by modern Biology.

“The outcome of evolution is a population or organisms, a species, adapted to survive in certain type of environment.”⁴

The species mentioned in the classifications⁵ of plants and animals in Jaina Biology show adaptations both in the physical environment and biotic environment which includes all the plants and animals in the same region,⁶ e. g. some plants and animals live on land in the same region, while some plants and animals live in the region of water⁷ as indicated in the *sthānapada* of the *Pāṇṇavaṇā* sūtra, regarding the habitats of plants upto those of five-sensed animals.

Some of the fundamentals of ecology, the study of the interrelations between living things and their physical and biotic environment, etc. have been discussed in the first section “Biologic Interrelation” of the second chapter : “The World Of Life.” Now the problems of

1. *Pāṇṇavaṇā* Sutta 2, *Thāṇapayām*, Sūtras 148-166, etc.
2. *Uttarādhayana* Sūtra 36.171.
3. *Pāṇṇavaṇā* Sūtra 1. 61-91. Biology, p. 570.
4. Biology, p. 570.
5. See *Thāṇapayām* of *Pāṇṇavaṇā* Sutta, 160 - 162. “*Vaṇṇasaikāyaṭhāṇāim*”, “*Agādesu taṭāgesu nadisu dahasu vavisu pukkhariṇisu dihiyasu gumjaliyasu saresudivesu samuddesu savvesu ceva jalāsaesu*”.
6. See also “*Veimdiyaṭhāṇāim*”, *Pāṇṇavaṇā* Sutta 163-166. “*Agādesu tatāesu nadisu divesu samuddesu savvesu ceva jalāsaesu /*”, etc.
7. *Thāṇapayām*, *Pāṇṇavaṇā* Sutta 2.

ecology will be discussed here more in detail as revealed in Jaina Biology.

Factors Regulating the Distribution of Plants and Animals ;

The study of the classification of organisms and their habitats reveals that probably no species of plants or animals is found everywhere in the world,⁸ for some parts of the earth are too hot, too cold, too wet, too dry, too something else⁹ for the organism to survive. That is to say, all the environments may not be suitable for each of the species of plant or animal for their survival.

Modern Biology also explains that "most species or organisms are not even found in all the regions of the world where they could survive. The existence of barriers prevents their further dispersal and enables us to distinguish the major biogeographic realms characterized by certain assemblages of plants and animals."¹⁰

It is found in Jaina Biology that each species requires certain materials for growth and reproduction.¹¹ It is presumable that it can be restricted if the environment does not provide a certain minimal amount of each one of these materials.

The distribution of each species is determined by its range of tolerance to variations in each of the environmental factors¹² as it is indicated by the birth of different species of plants and animals in different habitats – land, water and air,¹³ etc.

8. "Suhūmā savvalogammi, logadese ya bāyārā /", Uttarādhyayana Sūtra, 36.100 ; "Beiṁdlyā u. ḡegāhā evāmāyao / logegadese te savve, na savvattha viyāhiyā /", Ibid, 36.130.
9. "Teiṁdiya-logegadese te savve, Ibid, 36.139.
10. "Cāuriṁdīyā – logassa egadesammi, te savve parikittia (149) Ibid.
11. Paṁcemdiyā – "logassa e. adesammi, te savve u viyāhiyā /", Ibid, 36.158, Macchā, etc... "Loegadese te savve, na savvattha viyāhiyā /" Ibid 36.173
12. About birds "Logegadese te savve, no savvattha viyāhiyā /", Ibid, 36.188.
9. Sūtrakṛtāṅga II. 3.
10. Biology, p. 570
11. Sūtrakṛtāṅga II. 3. (Āhāranikṣepa) ; Knowledge of food
12. Sūtrakṛtāṅga II. 3. 43-62.
13. See Thānapayaṁ, Paṇṇavaṇā Sutta 2 ; Uttarādhyayana Sūtra, 36.171 ; Paṇṇavaṇā Sūtra 1.61. "Jalacara paṁcimdiyatirikkhajoniyā thalacarapaṁcimdyatirikkhajoniyā khaha-carapamcimdiyatirikkhajoniyā /"

It has usually been observed that certain stages in reproduction are critical in limiting organisms; seedlings¹⁴ and larvae¹⁵ are usually more sensitive than adult plants and animals.

According to modern Biology, "Some organisms have very narrow range of tolerance to environmental factors, others can survive within much broader limits. Any given organism may have narrow limits for another."¹⁶

It appears from a close study of the world of life in Jaina Biology in regard to the ecosystem that temperature,¹⁷ light,¹⁸ water,¹⁹ atmospheric gases²⁰ and food²¹ are some of the important limiting factors regulating the distribution of plants and animals.

"Temperature is an important limiting factor, as it is demonstrated by the relative sparceness of life in the desert and arctic. The role of light is important in controlling plants and animals. Plants and animals must have light for their survival but they had to evolve mechanisms for protection against too much or too little light.

Water is a physiologic necessity for all organisms, but it is a limiting factor primarily for land organisms.

14. Stages of embryonic seed (Jonibhūe bie), hypocotyl (first radicle = mūla), cotyledons (prathamapratas), epicotyl (prathamakisalaya) and its development or growth (vivaddhamāta), Paññavāṇī 1. 154. 9. 97-98. Biology, p. 571.

15. See Sūtrakṛtāṅga II. 3. 19-20 ; Tattvārthādhigama Sūtra II. 24. Three sensed beings e.g. Pipilikā (ant), trapusa vinas (cucumber weevils), tṛāṇapatra (hāraka) (Plant lice) and four sensed beings e.g. kīṭa (butter flies and moths), Pataṅga (grass hoppers and locusts) have larvae stage before coming into being (adult). Biology, p. 51.

16. Ibid, p. 571.

17. Sūtrakṛtāṅga II. 3.

18. Bhagavatī Sūtra 7. 3. 274-5.

19. Sūtrakṛtāṅga II. 3..

20. Sūtrakṛtāṅga II. 3.

21. Sūtrakṛtāṅga II. 3. "Āhāranikṣepa". "Some beings are born in earth as 'trees. These beings feed on the liquid substance of these particles of earth, the origin of various things ; these beings consume earth-bodies, water-bodies, fire-bodies, wind-bodies, bodies of plants, etc. "Puḍhavisu rukkhattāe viṭṭamī te jivā tesim nānāvihāṇoṇiyāṇam puḍhaviṇām sinehamāhāremti, te jivā abāremti puḍhavisarāṇam āusarāṇam teusarāṇam vāusarāṇam vāṇassasarāṇam" II. 3. 43, p. 91.

Atmospheric gases – the amount of dissolved oxygen is a limiting factor for certain forms living deep in the soil or on mountain heights and aquatic environments.²²

Even fire²³ may be a factor of ecologic importance.

“The knowledge of food for plants and animals as revealed in the Jaina work²⁴ shows that the need of living things for energy is food. Modern Biology defines that “the transfer of food energy from its ultimate sources in plants, through a series of organisms each of which eats the preceding and is eaten by the following is known as food – chain.”²⁵

“Man is the end of a number of food – chains, for example, man eats big fish, which ate little fish, which ate small invertebrate which ate algae.”²⁶

“The ultimate size of the human population is limited by the length of our food – chain, the per cent efficiency of energy transfer at each step in the chain, and by the amount of light energy falling on the earth.”²⁷

It is to be noted in Jaina Biology that parasites (anusūyas)²⁸ may also exist as members of food chains for example, mammals and birds are parasitized by fleas,²⁸ etc. and in the fleas, (damśa)^{28/a} etc., live

22. See Biology, p. 571. See also Sūtrakṛtāṅga II. 3 for environment.

23. “te jīvā āhāreṇti teusarīraṁ” Sūtrakṛtāṅga II. 3. 43, p. 91.

24. Sūtrakṛtāṅga II. 3. Āhāraṇikṣepa

25. Biology, p. 572.

26. Ibid

27. Ibid.

28. Sūtrakṛtāṅga II. 3. 53.

“Nānāvihāṇam tasathāvaraṇam poggalāṇam sarīresu vā, sacittesu vā, acittesu vā, anusūyaṭṭāc viuṭṭamāti, te jīvā tesirū nānāvihāṇam tasathāvaraṇam pāṇāṇam siñehamāhāreṇti, etc. up to tesirū tasathāvaraṇajōiyāṇam anusūyagāṇam sarīrā nānāvāṇṇā jāvamakkhāyam /”

“Te jīvā vikalendriyāḥ sacittesu manusyādiśarīreṣu yükālikṣadikatvenotpadyante tathā tātparibhujyamāneṣu mañcakādiśvacitteṣu matkuṇatvenāvirbhavanti /”

Tikā. ibid p. 102

28/a Bhaga 9.33.3 '4

protozoa²⁹ (kṛmi) which are in turn hosts of bacteria³⁰ "since the bacteria might be parasitized by viruses there could be a five-step parasite food - chain."³¹

It is known from the study of the classification of plants and animals and their distribution on land and in water that each region is inhabited by a host of animals and plants and there are many interrelationships³² - competition, commensalism, predation and other factors³³ between them that are also involved in determining whether or not some single species can survive there.

A biotic community³⁴ as found in Jaina Biology is composed of smaller groups, members of which are more intimately associated.³⁵ According to modern Biology, it is also known as populations, for there is no sharp distinction between a population and a community.³⁶ So a biotic community as noted in Jaina Biology is an assemblage of population living in a defined area or habitat (ṭhāṇa)³⁷ it can be either large

29. Tathā acittibhūteṣu manusyādiśarirakeṣu vikalendriyaśarireṣu vā te jīvā anusyūtatvena-paraniśrayā kṛmyāditvenotpadyante /" Tīkā, Sūtrakṛtāṅga, II. 3, p. 102
 'Evam dūrvāsaṁbhavattāe evam khuradugattāe' Ibid II. 3.58.
 "Khuradugattāe - carmakiṭatayā samutpadyante, idamuktāṁ bhavati-jīvatāmeva
 goṁahīṣyādināṁ carmaṇo, antaḥ prāṇīnaḥ saṁmūrcchhyante, te ca tanmāṁsacarmaṇi
 bhakṣayanti, bhakṣyantaścarmaṇo vivarāṇividahati, galacchoṇiteṣu vivareṣu
 tiṣṭhantastadeva śoṇitamāhārayanti, tathā acittagavādiśarīre api, tathā sacittā-
 cittavanaspatiśarīre api ghuṇakīṭakāḥ saṁmūrcchhyante, te, ca tatra saṁmūrcch-
 yantastacchariramāhārayantī /" Ibid. (Comm.) p. 102.

31. Biology, p. 572.

32. See the second (types of plants) and third (Classification of Animals) chapters.

33. See the first section of the second chapter. "Biologic Interrelationship." "The classification of living substances. "Mode of Nutrition of Plants and Animals," "Ecosystem, Habitat and Ecologic Niche" "Types of Interactions Between Species of Plants and Animals."

34. Ibid., Sūtrakṛtāṅga II. 3, Āhāraṇikṣepa; see the 1st section of 2nd chapter. "Interactions Between Species of Plants and Animals."

35. See the first section of the 2nd chapter; "Biologic Interrelation",," Sūtrakṛtāṅga II. 3.

36. Biology, p. 572.

37. See Ṭhāṇapayaṁ, Paṇṇavāṇā Sutta; Sūtrakṛtāṅga II. 3 ; Ecosystem and Habitat and Niche, of 1st section 2nd chapter.

or small. The concept that animals and plants live together³⁸ in an orderly manner in their habitats, not strewn haphazardly over the surface of the earth is "one of the important principles of ecology."³⁹ Modern Biology explains that "Biotic communities show marked vertical stratification. In a forest there will be successive strata of plants, mosses and herbs, shrubs, low trees and high trees."⁴⁰ Each of these strata has distinctive animal populations, even such highly motile animals as birds have been found to be restricted to certain layers - some are found to be restricted to certain layers - some are found only in shrubs, others only in the tops of tall trees".⁴¹

38. See Ecosystem, Habitat and Ecologic Niche of 1st section, 2nd chapter; Sūtra-kṛtāṅga II. 3; Thānapada, Pannavaṇā Sūtra.

39. Biology, p. 577.

40. See the type of plants in the second chapter, fourth section and B.

41. Ibid, p. 578.

(Fourth Section)

THE OUTCOME OF EVOLUTION : ADAPTATION

Although a clear cut idea of the outcome of evolution of plants and animals is not found in Jaina Biology, it has been noted in the second section of the first chapter "Characteristics of Living Substances" that each particular species of plant or animal has the ability to become adapted by seeking out an environment to which it is suited to make it better fitted to its present surrounding.¹ It appears from the study of Jaina Biology that in course of time organisms have become adapted and readapted² many times as their environment changed or as they migrated to a new environment.³

The analysis of this topic "The knowledge of food of organisms"⁴, the types of plants and animals⁵ and their habitats,⁶ etc. as recorded in Jaina Āgamas reveals that there is a tendency for each group of organisms to spread out⁷ and occupy as many different habitats as they can reach and which will support them⁸ because of the struggle for food and living space.⁹

1. See the second section "Characteristics of Living Substances", the first chapter "Cell structures and Functions".
2. Sūtrakṛtāṅga II. 3 ; Bhagavati 7. 3. 275 ; Pañṇavaṇā, Ṭhaṇapayaṁ ; Jivābhigama, 1. 34-36; Tarkarahasyadīpikā, V. 49 (Jaina matam), Ṭikā by Gunaratna.
3. Ibid, see the second chapter, the first section "Biologic Inter-relationship" Mode of Nutrition of Plants and Animals, "Ecosystem", "Habitat and Ecologic Niche" and the third section "Principles of Ecology" of the seventh chapter 'Evolution'.
4. Sūtrakṛtāṅga II. 3.
5. See the second chapter, fourth section - A and B " Types of Plants", and the third chapter "Classification of Animals".
6. Pañṇavaṇā Sūtra, Ṭhanapayaṁ ; Sūtrakṛtāṅga II. 3.
7. Trasa animals (motile animals) always move on for food and shelter. All movable beings spread out for food. Even the immovable plants spread out their roots for food. See Sūtrakṛtāṅga II. 3, 43.
8. See Sūtrakṛtāṅga II. 3. All motile animals do so for food and space.
9. Ibid.

According to modern Biology, "This evolution from a single ancestral species, of a variety of forms which occupy different habitats is adaptive radiation."¹⁰

As indicated in the topic "the knowledge of food", this adaptive radiation is obviously advantageous in enabling organisms to cap 'new sources of food'¹¹ and to escape from some of enemies.¹² The placental mammals¹³ provide a classic illustration of the process. There are dogs (suṇagā or Śvāḥ)¹⁴ and deer (mṛgas),¹⁵ etc., adapted for terrestrial life¹⁶ as shown by their classification into sthalacara (terrestrial) group¹⁷ in which running rapidly is important for survival ; bats (valguli),¹⁸ etc. equipped for flying in the air as khecara (aerial)¹⁹ being, the completely aquatic whales (timī)²⁰ and porpoises (śiśumārā)²¹ etc. as Jalacara²² aquatic animals in water. The classification of animals into sthalacara (terrestrial), Jalacara (aquatic) and Khecara²³ (aerial) animals in Jaina Biology throws light upon their habitats and ecology²⁴ to which they could grow and adapt, and make themselves better fitted in their survival.

Modern Biology states that "The number and shape of the teeth, the length and number of leg bones, the number and attachment sites

10. Biology, p. 582.
11. Sūtrakṛtāṅga II. 3. Mode of Nutrition of Plants and Animals (first section, second chapter)
12. For example, movable animals deer (mṛga) can escape from its enemy tiger (vyāghra) sometimes with its swiftness of biungular feet. See Sūtrakṛtāṅga II. 3. 23. (Knowledge of food)
13. Sūtrakṛtāṅga II. 3. 23
14. Sūtrakṛtāṅga II. 3. 23 ; Uttarādhyayana 36.180.
Paṇṇavaṇā Sutta 1.74 (Suṇagā) ; Tattvārthādhigama Sūtra II. 34.
15. Sūtrakṛtāṅga II. 3. 23 ; Uttarādhyayana Sūtra 36. 180 ; Paṇṇavaṇā 1.72 (miyā) Tattvārthādhigama Sūtra II. 34.
16. Paṇṇavaṇā 1. 69, 72, 74.
17. Ibid., Uttarādhyayana Sūtra 36. 180.
18. Paṇṇavaṇā 1. 87.
19. Ibid 1. 86 ; Tattvārthādhigama Sūtra II, 34.
20. Paṇṇavaṇā 1. 63. (timī)
21. Ibid. 1. 62. 67 ; Uttarādhyayana 36. 17 .
22. Ibid 1. 62.
23. Uttarādhyayana Sūtra 36. 171, Paṇṇavaṇā Sūtra 1. 61, 86
24. Sūtrakṛtāṅga II. 3.

of muscles, thickness and color of the fur, and so on, are some of the structures that are involved in adaptation.”²⁵

Conversely, it is found in Jaina Biology that many of the animals inhabiting the same type of habitat (e. g. water) have (developed) similar structures which make them superficially alike, even though they may be but distantly related. For example, the dolphins and porpoises (śīśumāras)²⁶ (which are mammals), both bony and cartilaginous fishes, “have all evolved streamlined shapes, dorsal fins, tail fins and flipper like fore and hind limbs which make them look much alike.”²⁷

In Modern Biology “this evolution of similar structures by animals adapting to similar environments is known as convergent evolution.”²⁸

It is suggestive from the study of Jaina Biology that adaptations for survival are evident in the colour^{28/a} and pattern of plants and animals²⁹ as well as in their structures and physiologic processes.³⁰

The evolution and adaptation of each species as suggested by biologic interrelation³¹ in Jaina Biology have not occurred in a biologic

25. Biology, p. 583.

26. Sūtrāktāṅga II. 3. 57 (macchāṇam java saṁsamāraṇam)
Uttarādhyayana Sūtra 36. 172; Paṇṇavaṇā Sūtra 1. 67.

27. Biology, p. 583.

28. Biology, p 583.

28/a “Nimbamba Jambu .. Palāsa karamjeya” Paṇṇavaṇā 1. 40. 13 – four sensed beings Kīṇhapattā nilapattā lohiyapattā haliddapattā sukkilapattā cittapakkā viciittapakkha etc.

The adaptations of the four sensed beings such as, Andhiya (a kind of four sensed beings), pottiya (gnats), makṣikā (flies), maśaka, (mosquitos), pataṅga (grasshoppers) etc. for survival are evident in the colour as is evidenced by the fact of the mention of others in the same class kīṇh.patta, (four sensed beings having black-coloured wings), nil.pattā (four sensed beings having blue coloured wings) etc.

29. “Eesim vaṇṇao ceva, gaṁḍhao rasaphāsao /
Saṁṭhānāo sao vāvi, vihānāim sahasraso //”,
Uttarādhyayana Sūtra 36.115, 116, 135, 144, 154. 169, 178. .93, 202.

30. See the second chapter and the fourth chapter for the plant structure and plant physiologic processes and animal (man's structure and physiologic processes respectively.)

31. See the first section of the second chapter “Biologic Interrelationship”.

vacuum, independent of other forms ; instead many species have had a marked influence on the adaptation of other species. As a result many types of cross-dependency between species³² have arisen. Some of the clearest and best understood of these types involve insects (kiṭa), e.g. bhramaras (bees), kiṭa - pataṅga (butter-flies and moths)³³. Insects are necessary "for the pollination of a great many plant"³⁴ e.g. gourd plant (tumbi).³⁵ It may be said that flowering plants have developed bright colours and fragrance, presumably to attract insects and birds and ensure pollination, e. g. Utpala³⁶ (*Nymphaea caerulea*, blue lotus), pauma³⁷ (*Nelumbium Speciosum*, lotus), Nalina³⁸ (water-lily, *Nelumbium Speciosum*).

Other types of species to species adaptation are found as ones of host-parasite,³⁹ prey-predators,⁴⁰ commensals⁴¹ and mutualistic interdependence.⁴²

Terrestrial Life Zones (Sthalacarasthānas) : Biomes

As pointed out in the first section of the second chapter in connection with the habitat and niche of the living things-plants and animals, a physical area, some specific part of the earth surface, the place where an organism lives, air, soil, or water and the status of an

32. See the first section of the second chapter "The world of Life Plants" ; Biologic Interrelationship and types of Interactions between Species of Plants and Animals.

33. Uttarādhayayana Sūtra 36.146 : Paññavaṇā Sūtra 1.58 ; Tattvārthādhigama Sūtra 11. 24

34. Biology, p. 586.

35. Paññavaṇā 1. 4. 5. (Tumbi)

36. Bhagavatī Sūtra 9. 33. 385 ; 11. (I-8). 416.

37. Ibid. 11. (I-8). 416.

38. Ibid,

39. Sūtrakṛtāṅga II. 3. 58.
"Te jivā .. ḥāṇāvihāṇāṁ tasathāvaraṇāṁ poggalāṇāṁ sariresu vā .. aṇusūyattae viuṭṭāmī"

40. Ibid. II. 3. 43.
"Te jivā ḥāṇāvihāṇāṁ tasathāvaraṇāṁ pāṇāṇāṁ sarīraṁ accittamī kuvvamī etc."

41. Ibid. II. 3. 44.

42. Ibid. II. 3. 64. (Kūhana), 54 (Seval), 55 (taṇa), etc.

See the first section of the second chapter "Biologic Interrelationship" Types of Interactions Between Species of Plants and "Animals" for all these facts of species adaptation.

organism within the ecosystem form the two basic concepts – habitat and niche which are useful in describing the ecologic relations of organisms.⁴³ In dealing with the ecosystem and adaptation of organisms in Jaina Biology it is revealed that the biogeographic regions of the world are regions composed of a whole continent (dvipa) or a large part of it (i. e. sthalacarasthānās)⁴⁴ and characterized by certain unique animals and plants.⁴⁵ Within these biogeographic divisions and arising as a result of complex interactions of climate, other physical factors and biotic factors are large, distinct, easily differentiated community units, called biomes in modern Biology.⁴⁶

It is suggestive from the study of the classification of plants⁴⁷ into bacteria, algae, fungi, herbs, shrubs, creepers, grasses and trees in Jaina Biology that in each biome the kind of climax vegetation is uniform, but the particular species of plant may vary in different parts of biome. The kind of climax vegetation depends upon the physical environment and the two together determine the kind of animals present.⁴⁸

According to modern Biology, “The definition of biome includes not only the actual climax community of a region, but also the several intermediate communities that precede the climax community⁴⁹”.

Aquatic Life Zones (Jalacarasthānās)

Aquatic Life Zones may be divided into Marine Life zones⁵⁰ and Fresh Water Life zones for the convenience of study of biomes in these habitats.⁵¹

43. See the first section of the second chapter for Habitat in Niche and Ecosystem.

44. See Paññavānā Sutta 2, Thānapayam.

45. Paññavānā Sutta 1.69.
“Thalayaraparameñiyatirikkajoniyā duvihā paññattā / tainjahā – cauppayathala-
yaraparameñiyatirikkajoniyā ya parisapprathalayaraparameñiyaiirikkajoniyā
ya / etc. Besides, all the beings from one-sensed plants and animals upto five
sensed animals live on earth, according to Sthānapada, Prajñapāna Sūtra II.
148-150, etc.

46. Biology, 586.

47. See the second chapter, four section A and B : “Types of Plants” etc.

48. See the first section of the second chapter : “Biologic Inter relationships.”

49. Biology, p. 586

50. See Thānapayam, Paññavānā Sutta 2. All beings from one-sensed except air
bodied and fire bodied beings up to the five - sensed beings live in Aquatic life
zones – Marine life zones and Free water Life zones. See also the habitats of
ap-kāyajivas, Jalaruhas (Paññavānā 1.51), Pañcendriya Jalacarajivas (Paññavānā
1.62).

51. Thānapayam, Paññavānā 2

Marine Life Zones :

The ocean (samudda)⁵² is one of reservoirs of living things. It is clear that the total weight of living things (biomass) in the ocean far exceeds that of all living things on land fresh water as it is suggested by the sthānas (habitats) of all beings from one-sensed to five-sensed animals.

“The seas are continuous one with another and marine organisms are restrained from spreading to all parts of the ocean only by factors, such as, temperature, salinity and depth. The currents of the water of the sea not only influence the distribution of marine forms but also have marked effects on the climates of the adjacent land masses”.⁵⁴

The study of the habitats of Tiryañcajīvas from one-sensed beings except vāyukāyajīvas and Tejakāyajīvas up to five-sensed animals in Jaina Biology reveals that like the land the ocean (samudra) consists of regions characterized by different physical conditions and consequently inhabited by specific kinds of plants⁵⁵ and animals.⁵⁶

Fresh Water Life Zones :

As described in the Jaina literature, fresh water habitats of plants and animals may be divided into two zones, viz. standing water-lakes (dahesu), ponds (pukkhariṇīsu) and swamps (vāvisu?) and running water - river (nadīsu), creeks (bilesu?) and springs (ujjharesu - nijjharesu),⁵⁷ each of which may be further sub-divided. It is noted in Jaina Biology that biotic communities⁵⁸ of fresh water habitats are in general more familiar than the salt water ones of the ocean.

52. Ibid

53. Ibid.

54. Bioiogy, p. 591.

55. Samuddesu.. bādaravaṇassaikaiyāṇam pajjattāṇam ṭhāṇā paṇṇattā, etc. Paṇṇavanā, 2, ṭhāṇapayam.

56. Ibid.

57. ṭhāṇapayam, Paṇṇavanā Sutta 2, 151-153.

“Talācesu “nadīsu”; dahesu “vāvisu pukkhariṇīsu dihiyāsu gumjāliyāsu saresu sarapamtiyāsu sarasarapamtiyāsu bileṣu ... ujjharesu nijjharesu cillalesu pallalesu vappinesu dīvesu samuddesu savvesu ceva jalāsaesu jaṭhānesu 4. etthaṇam badara ḫvkkaiyāṇam pajjattāṇam ṭhāṇā paṇṇattā / Ibid. 1.163 ; 1.164. 1.165 1.166.

58. See the second chapter, fourth section A and B.]

“Types of plants” and the third chapter “Classification of Animals”.

'Fresh water habitats change much more rapidly than other life-zones ; pond becomes swamps, swamps become filled in and converted to dry land, and streams erode their banks and change their course.'⁵⁹

It is found that the aquatic plants and animals as described in Jaina Biology may change markedly and show ecologic successions similar to those on land. The large lakes (hada) are relatively stable habitats and have more stable populations of plants and animals.⁶⁰

The Dynamic Balance of Nature

A close study of the biologic inter-relationship of plants and animals, their mode of nutrition, ecosystem, habitat and niche, and types of interactions⁶¹, and principles of evolution, its living evidence, principles of ecology and the outcome of evolution : adaptation⁶² as explained in Jaina Biology in some form reveals that the communities of plants and animals are constantly undergoing an analogous reshuffling⁶³ and the concept of the dynamic state of communities is a valid one. Plant and animal populations are constantly subject to changes in their physical and biotic environment⁶⁴ and must adapt or die as suggested by Āhārapadanikṣepa (knowledge of food) of the Sūtrakṛtāṅga.⁶⁵

"A population may vary in size but if outruns its food supply, like the Kabab deer or the lemmings, equilibrium is quickly restored."⁶⁶

Communities of organism-plants and animals as described in Jaina Biology exhibit growth,⁶⁷ specialization⁶⁸ and interdependence,⁶⁹ charac-

59. Biology p. 594.

60. See Thāṇpayām, Paṇṇavaṇā 2.

61. See the first section "Biologic Interrelationship", etc. of the second chapter : The world of Life : Plants. See also Sūtrakṛtāṅga II. 3. Āhāranikṣepa (knowledge of food)

62. See The 7th chapter and 1st chapter second section.

63. See Sūtrakṛtāṅga II. 3. Āhāranikṣepa (knowledge of food).

64. See the first section of the second chapter "Biologic Interrelationship", etc.

65. Sūtrakṛtāṅga II. 3.

66. Biology, 594.

67. Tarkarahasyadipikā, Tīka on V. 49 (Pratiniyatavṛddhi).

68. See the 2nd chapter 1st section - "Distinction Between Plants and Animals".

69. See the 1st section of the second chapter "Biologic Interrelationship", etc.

teristic form,⁷⁰ and even development from immaturity to maturity old age and death.⁷¹

70. See the 1st section of the first chapter- "Characteristics of Living substances", the second chapter on plants structure and the fourth chapter "Organisation of the body."

71. Taikarahasyadipikā, Tīkā on V. 49, Guṇaratna, p. 159.

"Vanaspata�ah ṣacetanā bālakumāravṛddhāvasthā-pratiniyatvṛddhi-svāpaprabodhasparśādīdhetukollāssasaṁkocāśrayopasaṁpanādiviṣṭānekakriyāchinnāvayavam-tanī-pratiniyatapradeśāhāragrahaṇavṛksayurvejābhīhitāyuṣkeṣṭāniśāhārkdīmīttā-vṛddhīhāni, etc. upto viśiṣṭaṣṭriśarīravat" /" "ṣacetanā vanaspatayo janmajarāmeraṇarogādināṁ samuditānāṁ sadbhāvāt" /" Ibid. p. 159.

Ten daśas, "Evam jāyassa jaṁtussa kameṇa dasa dasā evamāhijjamti tamjāhā bālā 1 kiḍḍā 2 māmā 3 balā ya 4 paṇṇā ya 5 hāyaṇi 6, pavaṁca 7, pabbhāra 8, mūmūhi 9 sāyanīya dasamā ya 10 kāladasā 1 31", Tandula Veyāliya, p. 15

EIGHTH CHAPTER

CONCLUSION

A Survey of the Plant and Animal Kingdoms as revealed in Jaina Biology in the light of modern Biology

A study of the plant and animal kingdoms as found in the Āgamas and post-āgamic works reveals that Jaina Biology is the science of living thing (jivadravya) which is different from non-living (ajivadravya)¹. The thought on the world of life : plants and animals, began with the Jainacāryas on the basis of the concept of animism and non-violence (ahimsā) in the ancient past, along with the idea of the requirement of food to sustain life with a sense of the spiritual value of the life of all beings. They have studied the plant and animal kingdoms with some carefully controlled observation and made a discovery in the world of life : Plants and animals, by their critical observation and methods in some details so that their followers also can repeat them in their field. They have recorded the results of their observations, made discussion on the conclusion to be drawn from them, perhaps formulated a theory to explain them and indicated the place of these biological facts in the present body² of scientific knowledge contained in the Jaina Āgamas and post-āgamic works, of course without scientific verification of modern Biology.

The facts of Jaina Biology as embodied in the Jaina Āgamas are gained by the application of the scientific method, yet it is difficult to reduce this to a simple set of modern Biology that can be applied to the Jaina Biological science, for the confirmation of the statement by the independent observation of another in any scientific investigation is demanded by the sceptical scientists of the present age.

A method has been followed by the Jainacāryas to see through a mass of biological data. The idea that living systems are distinguished from non-living ones by some mysterious vital force (parypāti?) has been accepted in Jaina Biology. There appear to be no exceptions to the generalization that all life comes only from living things.

1. Bhagavatī Sūtra 25. 2. 720 ; Sthānāṅga 2. 95; Paññavānā Sutta 1,3, p. 4; Jivābhigama. p. 5.
2. Bhagavatī, Sthānāṅga ; Paññavānā ; Jivābhigama ; Acārāṅga ; Sūtrakṛtāṅga, etc.

Jaina Biology provides connecting proof that micro-organisms (nigodas), bacteria (earth quadrates, etc.) are not capable of originating from non-living material by spontaneous generation. It seems that micro-organism (nigodas) require the presence of pre-existing micro-organisms (nigodas).

Nigodas do not arise *de novo* from non-nigodas, just as viruses do not arise from non-viral material.³ Elements of the idea that all of the many types of plants and animals existing at present time were not created *de novo* and were externally existing and have descended from previously existing organisms are clearly expressed in the Jaina Āgamas but they have their gradations.

The studies of the development of many kinds of plants and animals from embryo or fertilized egg to adult as found in Jaina Biology lead to the generalization that organisms tend to repeat in the course of their embryonic development, some of the corresponding stages of their evolutionary ancestors, i.e. embryos recapitulate some of the embryonic forms of their ancestors.⁴

A careful study of communities of plants and animals in a given habitat as described in the Jaina Āgamas reveals that all living beings in a given region are closely inter-related with one another and with the environment.⁵

It conceives the idea that particular kinds of plants and animals are not found at random over the earth but occur in interdependent communities of producer, consumer and decomposer organisms together with certain non-living components. Those communities can be recognised and characterized by certain dominant members of the group, usually plants, which provide both food and shelter for many other forms of life. This ecosystem is one of the major unifying generalizations of Biology.⁶

Jaina Biology explains that the fabric of life of all plants and animals is *paryāpti* (vital force) or *prāṇa* (life force) in another way, i. e. *paryāpti* like protoplasm appears to be the actual living material

3. Bhagavati 25. 5. 749 ; 12. 2. 443 ;
Biology, C. A. Villee p. 9.

4. Bhagavati, 1. 7. 61 ; Tāndulaveyāliya, 6, p. 10,

5. Bhagavati 6. 7. 246 ; 6. 5. 330 ; 7. 3. 277 ; 8. 3. 324, 8. 5. 330 ; 21. 2. 691 ;
22. 6. 692 ; 23. 1. 693 ; etc. Sūtrakṛtāṅga, II. 3.

6. Ibid.

of all plants and animals. Jain paryāpti⁷ and prāṇa,⁸ the two unique forces, not explainable in terms of physics and chemistry, are associated with and control life. The concept of these forces may be called vitalism which contains the view that living and non-living systems are basically different and obey different laws. It is reasonable to suppose that paryāpti, a mysterious aspect of life, although not identifiable with protoplasm, comes nearer to the latter because of its unique functions.⁹

All living substances (Jīvadrayyas) have, to a greater or lesser extent, the properties of specific size¹⁰ and shape,¹¹ metabolism,¹² movement,¹³ irritability,¹⁴ growth,¹⁵ reproduction,¹⁶ and adaptation.¹⁷

Many of the phenomena of life that appear to be so mysterious, as explained by the Jainācāryas, such as, respiration, instinct, speech,

7. Navatattva prakaraṇa v, 6, p. 12, Dharmavijaya. Gommaṭasāra, Jivakaṇḍa, vv. 118–119, Nemicandra; Lokaprakāśa, Vinayavijayaji, Pt. I, 3rd Sarga, vv. 15ff.
8. Jīvavīcāra, vv. 42, 43; Gommaṭasāra (Jīva). v. 129.
9. See Biology, p. 16.
10. Bhagavati 19. 3. 652–53; 25.1. 717; Uttarādhyayana 35.70; Pañṇavanā (sūkṣma-bādara etc); Gommaṭasāra (Jivakaṇḍa), v. 177, v. 183.
11. Pañṇavanā, Samhānāidāracchakāra, 983–89, p. 241; Bṛhatsaṃgrahaṇī, Candrasūri, vv. 243–5. Mūlācāra, Pt. III, 12, v. 49, Paryāptyādhikāra, Vaṭṭakhera with ṭīkā of Vasunandi Siddhānta Cakravarttin, p. 207; Lokaprakāśa, Pt. I, 3rd Sarga, vv. 205–10, pp. 98–99. Gommaṭasāra (Jivakaṇḍa), v. 211.
12. Sūtrakṛtāṅga II. 3; Bhagavati 7, 61–63; 7. 3. 275–6; Pañṇavanā, Āhārapadāra, Pajjattidāra, 2nd uddeśaka, p. 406. Tandulaveyāliya, pp. 3–10; Navatattva prakaraṇa, v. 6, p. 12. Lokaprakāśa, Pt. I, 3rd Sarga, vv. 15–21ff; Gommaṭasāra (Jīva), Ch. 1III, vv. 119–121; Mūlācāra II, 12–4; Tarkarahasyadīpikā on Śaddarśana Samuccaya, Jainamataram, v. 49, Guṇaratna.
13. Ācārāṅga, Book I, 9. 1. 14; Sūtrakṛtāṅga II. 2. 18, 60, Sthānāṅga 2. 4. 100; Bhagavati, 25. 4. 789, Uttarādhyayana, 36.68, Jīvābhigama; p. 12. Mūlācāra, Pt. I, 30 (226), p. 295; Tattvārtha Sūtra, Umāsvāti, 2. 12–14, Tarkarahasyadīpikā, Guṇaratna v. 49.
14. Bhagavati 3. 9. 170; 2. 4. 99; Pañṇavanā, Indriyapadāra 15, Puṭṭhadāra, etc. Jīvābhigama, Jyotiṣka, Tarkarahasyadīpikā, v. 49.
15. Abbuya (cells ?), Tandula Veyāliya, 2, p. 6. It is also suggestive from the reference to lakhs of follicles (pores) in the skin of the human body that there are cells in the body of man and other vertebrates, Ibid, 2. p. 6.
16. Pesī (muscle tissues). Ibid, p. 6.
Pesī (tissues) is made of abbuyas (arbudas=cells).
17. A single fertilised egg (Kalala) develops gradually into many-celled or five-celled embryo (pañcapīṇḍas) by the process of cleavage, indicating that the egg cell splits or divides. Out of five pīṇḍas 2' arms, 2 legs, and the head come into being, Tandula Veyāliya 2, p. 6.

passion, senses, condition of soul (*leśyā*), feeling (*vedanā*), etc. of living things, have proved to be understandable by invoking a unique life force, while other aspects of life can be explained by physical and chemical principles in the light of future research in the fields of Biology.

The study of the organizations of plants and animals, from the finest plants (*sūkṣma vanaspatis*) to higher plants (*bādara vanaspatis*) and from the finest earth quadrates (*pṛthivikāyajīvas*, etc.) to man (*manuṣya*) as described in the Jaina Āgamas and post-Āgamic works reveals that the bodies of all plants and animals are composed of cells¹⁸ and tissues.¹⁹ But the Jainācāryas do not make any clear analytical study of cells and tissues of plants and animals there as they are treated in modern Biology. New cells can come into being only by division of previously existing cells.²⁰

There takes place the cellular metabolism of animal organisms, e.g. men, from the moment of their birth up to their death in the following manner that the food-stuff, when taken in, is transformed into molecules of nutrient and chyle which in turn get transformed by vital force into different elements of organism, such as, blood, flesh, fat, bone, marrow, semen, etc. in successive order.²¹

The metabolic activities of animals, plants, and bacteria cells are remarkably similar,²² despite the difference in the appearances. One of the metabolic difference between plants and animals is the ability of green plants²³ to carry on photosynthesis, to trap the energy of sunlight and to use it to synthesize compounds.

In addition to the general metabolic activities Jaina Biology throws some light upon special metabolic activites of certain animals and

18. Lokaprakāśa, Pt. I, 3rd Sarga, vv. 18-21.

Navatattva prakaraṇa, v. 6, pp. 12, 13, 14, 15, 16.

19. Śaḍḍarśana Samuccaya with Guṇaratna's Commentary, Tarkarahasyadipikā, 158-9.

20. Bhagawati 7. 3. 270,

21. Bhagawati 7. 3. 275-6.

22. "Bādarasyodyotena sahitasya". One-sensed bacteria, water-bacteria and plant-bacteria emit cold light, Karmagrantha 6th. p. 186.

Two-sensed worms-kṛmis - (protozoa) emit cold light. Uttarādhyayana 36. 128. See Tattvārthasūtra II. 24

23. Karmagrantha I, p. 85; Nūpuraka (Annelida). TS., II. 24; (Gaṇḍupada) (Crustaceans), Ibid. Śatapadī (Centipedes), Ibid. Śaṅṭha (Molluscs), Ibid ; Khadyota (Glow worm), Tarkarahasyadipika 156.

plants, Green plants²⁴ can photosynthesize; certain bacteria²⁵ and animals²⁶ can produce light. Certain plants produce wild variety of substances—flower, pigments,²⁶ perfumes,²⁷ many types of drugs,²⁸ and bacteria,²⁹ and molds, certain animals can make deadly poisons³⁰ and also antibiotics³¹ like the best chemists.

The world of Life : Plants. Biologic Inter-relationship.

At first glance the world of living substances (Jivadravyas) as revealed in the Jaina works appears to be made up of a bewildering variety of plants and animals,³² all quite different and each going its separate way at its own pace.

A close study of the world of living things as described in the Jaina Āgamas reveals that all organisms, whether plant or animal, have the same basic needs for survival, the same problems of getting food³³ for energy, getting space to live,³⁴ producing a new generation³⁵ and so on.

24. Mañjishṭhā (Indian Madder), Bhagavatī, 8.6.334.
25. Ketaki flower (Forula, Asafotida), Bhagavati, 22. 2. 692 ;
Haritaga (Terminalia Chebula), Ibid, 21.2. 692;
Bhallāya (Acajou, especially acid quince for medicine). Ibid.
26. Arjuna (the plant Calotropis Gigantea for optic nerve), Ibid, 2. 3. 1. 693 ;
Bhaṅgi (Cannabis Sativa), Ibid., 23. 5. 693 ;
Tulsi (Roly basil), Ibid., 21. 8. 691.
27. Sūtrakṛtāṅga II. 3.
28. Vṛścīka (Scorpion), Maṇḍūka (frog), uraga (snake), Bhagavati, 8. 7. 376.
Ahī (a class of snake), Ajagara (a class of snake), Ibid, 15. I. 560.
29. Nakula (mongoose), Ibid., 8. 3. 325, 15. 1560.
30. Sūtrakṛtāṅga II. 3. Bhs. 33. 1. 844, 7 ; 5. 282, etc.
Uttarādhyayana Sūtra 36. 68-202.
Paññavānā, jivapaññavānā 1. 14-138
Gommaṭasāra (Jivakāṇḍa), 1. 35, 70, 71, 72, etc.
31. Sūtrakṛtāṅga II. 3. 40-62.
32. Ibid.
33. Ibid.
34. It is suggestive from the study of the world of life in Jaina Biology on the basis of the structures (Saṁsthāna) of living form—plants and animals, on the physiologic and biochemical similarities and differences between species, etc. and on the analysis of the genetic constitution of present plants and animals, i. e. anatomy, physiology and biochemistry of plants and animals, their embryologic and generic histories as outlined in Jain Biology and the manner in which they are distributed over the earth's surface.

In solving their problems, plants and animals have evolved into a tremendous number of different forms, each adapted to live in some particular sort of environment. Each has become adapted not only to physical environment, but also to the biotic environment, all plants and animals living in the same general region. Living organisms are inter-related in two main ways, evolutionary descent³⁶ and ecologically,³⁷ one organism may provide food or shelter for another³⁸ or produce some substances harmful to the second.

The Jainācāryas have tried to set up systems of classifications of plants and animals based on natural relationships,³⁹ putting into a single group those organisms which are closely related in their evolutionary origin.⁴⁰ Since many of the structural similarities⁴¹ depend on evolutionary relations,⁴² classification of organisms is similar in many respects to one of the principles based on logical structural similarities.⁴³ Many plants and animals fall into easily recognizable, natural groups ; their classification presents no difficulty.

It is indicated in Jaina Biology that some organisms can synthesize their food,⁴⁴ hence they may be called autotrophic (self-nourishing),

- 35. Sūtrakṛtāṅga II. 3, 43-2 ; Bhagavatī 7. 5. 282
- 36. Sūtrakṛtāṅga II. 3, 43-62
- 37. Bhagavatī 8. 2. 316
- 38. E.g. ekendriya, dvīndriya, caturindriya and pañcendriya organisms are classified on the basis of natural relationships. Similarly, Jalacara and Khecara organisms are classified to their natural relationships, as they are closely related in their evolutionary origin.
- 39. Sūtrakṛtāṅga II. 3 ; Jivābhigama 3. 1. 96
Bhagavatī 7. 5. 282 (aṇḍaja, potaja and saṁmurcchima) ;
Uttarādhyayana Sūtra 35, 171 ff. ; Jivābhigama Sūtra 33.1 34, 35 ; Pañṇavānā, Jivapañṇavānā (Jalacara, Sthalacara and Khecara and Manuṣyaprajñāpanā) 29-34.
- 40. Bhagavatī 8.3.324 ; 7.3.277; 7.5.282; Jivābhigama Sūtrā, 3.1.91; 1.33, 1.34; 1.35, 1-36 ; Uttarādhyayana, 36.135, 144, 154, 169, 178, 179-186, 19', 202 ; Pañṇavānā pp. 30, 31 ; TS. 2.24, 34,
- 41. Ibid.
- 42. Ibid.
- 43. Sūtrakṛtāṅga II. 3.
- 44. Bhagavatī 7. 3. 275.

e. g. green plants⁴⁵ and purple bacteria⁴⁶ (i. e. sulphur bacteria=Saṅgamdhie); some organisms cannot synthesize their own food from inorganic materials, therefore, they live either at the expense of autotrophs or upon decaying matter.⁴⁷ They may be called heterotrophs. All animals, fungi (pañaga) and most bacteria are heterotrophs.

A study of the mode of nutrition of all organisms including plants, aquatic, terrestrial and aerial beings, and man, etc. as mentioned in the Jaina Āgamas shows that plants and animals are not independent of other living things but are interacting and interdependent parts of larger units for survival. So their interaction and interdependence bring to light that ecosystem which is a natural unit of living and non-living parts that interact to produce a stable system in which the exchange of materials between living and non-living parts follows a circular path, e.g. aquatic organisms-fish, green plants, like sevāla, etc. and snail (śambuka)⁴⁸ form a very small ecosystem in their habitat-water in a pond or lake.

The outline of ecosystem of Jaina Biology brings to light two basic concepts—the habitat⁴⁹ and ecologic⁵⁰ niche useful in describing the ecologic relations of organisms.

There take place the different types of interactions between species of plants and animals in several different ways due to their search for food, space or some other needs, e.g. the relationship of competition⁵¹

45. Sulphur bacteria (Saṅgamdhie) (Uttarādhyayana and Sūtrakṛtāṅga II. 3.61) may be identified with purple bacteria of Biology.

46. Sūtrakṛtāṅga II, 3, 20, 21, 22-28. All animals live at the expense of autotrophs in one way or other except some carnivorous animals, Ibid II. 3.16.

47. Fungi and some bacteria feed on the decaying matters, as it is found that some beings are born in earth, growing there in particles of earth that are the origin of various things, some issue forth as Aya, Kāya, Kuhana (mushroom), etc., from the decomposed things in the earth.

48. Tattvārthaśādhibhāga Sūtra II 24.

49. Sūtrakṛtāṅga II. 3. 1-12, 3 ; (trees), 16 (soil), 17(water), 18 (trees), 21 (earth), 22 (water), 23 (earth surface), 26 (aerial), 27 (animate or inanimate bodies).

50. Ibid., II. 3.2 (liquid substance) of the particles of earth, the bodies of manifold movable being, 3-5 (sap of the trees), 20 (sap of trees), 21 (mother's milk) boiled rice, etc.), 22 (mother's humours and plants), 23 (both movable and immovable beings), 24 (wind), 27 (the immovable creatures).

50. Sūtrakṛtāṅga II. 3.2.

51. Ibid. II. 3.3.

or predatorism, commensalism,⁵² and mutualism,⁵³ parasitism⁵⁴ between them.

The brief survey of the classifications of living things—plants and animals, their distinctions, mode of nutrition, ecosystem, habitat, and ecologic niche, and types of interactions between species as found in Jaina Biology gives a picture of the world of plants and animals, all related closely or distantly by evolutionary descent, and bound together in a variety of inter specific interactions.

As regards the properties of green plants Jaina Biology reveals that the green plants are the primary producers of the living world. The properties of the pigment that gives them their green colour, i. e., chlorophyll, enable them to utilize the radiant energy of sunlight to synthesize energy-rich compounds, such as, liquid substance (sineha)⁵⁵ from water and air.⁵⁶

Land plants⁵⁶ absorb water required for the photo-synthetic process through their roots; aquatic plants⁵⁷ receive it by diffusion from the surrounding medium.

The reference to the taking of air⁵⁸ by plants suggests that the cellular respiration⁵⁹ of plants utilizes ucchvāsavāyu⁶⁰ (oxygen ?) and releases nihśāsavāyu⁶¹ (carbon dioxide ?) from the liquid substances to the forms of biologically useful energy. These occur in green plants as they do in every living cell of organism.

Land plants have the cellular thick wall (tvac)⁶² as in the woody stems of trees and shrubs. They serve directly for the support of the plant body and they have also rather thin wall⁶³ which provides support indirectly by way of pressure. Besides, trees and shrubs have gūḍhaśirā (xylem) and ahirūyam⁶⁴ (phloem) to help support their trunk.

52. Bhagavati, 7.3. 275 ; Sūtrakṛtāṅga 11. 3.16 (Kuhana), 18 (sevāla), etc.

53. Sūtrakṛtāṅga II. 3. 27.

54. Sūtrakṛtāṅga II. 3. 43.

55. Ibid,

56. Lokaprakāśa, I, Sarga 5, vv. 107-8 ; see Bhagavati 7. 3. 276.

57. Sūtrakṛtāṅga II. 3.54.

58. Sūtrakṛtāṅga II. 3.43.

59. Ibid., Lokaprakāśa, 5. 75, p. 361.

60. Lokaprakāśa, 5. 32, 33. p. 353 ; Navatattva prakaraṇam p. 14

61. Lokaprakāśa 5, 75, p. 361 ; Navatattva prakaraṇa, p. 14,

62. Sūtrakṛtāṅga II. 3, 47 ; Lokaprakāśa, 1. 5. 79, p. 363,

63. Lokaprakāśa, 1. 5. 96, p. 365.

64. Paññavanā, Vanaspatikāyajiva Paññavanā, 54-84 ;

Jivavicara, 12 ; Gommaṭasāra v. 187 (Jivakāṇḍa)

The nutrients of plants are either made within the cells or are absorbed through the cell membranes. The nutrients synthesized are either used at once⁶⁵ or transported to another part, such as, the stem, or root⁶⁶. The insectivorous plants,⁶⁷ although without an organized digestive system etc. do secrete digestive enzymes⁶⁸ similar to those secreted by animals.

Plants accumulate reserves of organic materials for use during those times when photosynthesis is impossible at night or over the winter⁶⁹ when leaves fall.

An embryo plant cannot make its own food until the seed has sprouted and the embryo has developed a functional root,⁷⁰ leaf⁷¹ and stem⁷² system.

The simpler plants consisting of single cell or small group of cells⁷³ have no circulatory system. It is suggestive in Jaina Biology that simple diffusion, augmented in certain instance by the process of active transport by air⁷⁴ suffices to bring in the substance,⁷⁵ required by the plant. Gūḍhaśiras⁷⁶ (Xylem) tubes probably transport water and minerals from the roots up the stem to the leaves, while ahirūyam⁷⁷ (phloem) tubes may probably transport up as well as down the nutrient stems for storage and use them in the stems and roots etc.

The circulatory systems of higher plants are simpler than those of higher animals and constructed on an entirely different plan in Jaina Biology. Plants have no heart and blood vessels. Transportation of

65. Sūtrakṛtāṅga II. 3. 43.

66. Ibid, II. 3. 46.

67. Sūtrakṛtāṅga II. 3. 27.

68. Ibid.

69. Bhagavati, 7.3. 274 ; Lokaprakāśa, 1. 5 109-10.

70. Vide Lokaprakāśa, 1. p. 361, 1. 5. 74.

71. Ibid.

72. Ibid.

73. Uttarādhyayana 36.92 ; Paññavānā, Vanaspatikāyajivapaññavānā, 1.35 p. 16. (Sūkṣma Vanaspati).

74. Lokaprakāśa, 5. 75, p. 361.

75. Ibid. Sūtrakṛtāṅga II. 3.43.

76. Paññavānā, Vanaspatikāyajiva Paññavānā, 54-84 ; Jivavicāra, 12 ; Gommaṭasāra (Jivakāṇḍa) v. 187

their nutrients from soil is accompanied by the combined forces of transpiration⁷⁸ pull and root pressure.⁷⁹

Plant sap (siñeha or rasa)⁸⁰ as mentioned in Jaina Biology is somewhat analogous to the blood plasma of man and higher animals, which is complex solution of both organic and inorganic⁸¹ substances which are transported from one part of the plant to another by the combined action of suction force which is connected with transpiration pull and root pressure.⁸²

A striking difference between plants and animals as found in Jaina Biology is that plants excrete little or no waste. Since plants are lomāhārins⁸³ (absorbers of nutrients through the epidermal cells) nor carry on muscular activity like kabalāhārin⁸⁴ man and higher animals, "the total amount of nitrogenous waste is small and may be eliminated by diffusion as nitrogen containing salt from the root into the soil."⁸⁵

The activities⁸⁶ of the various parts of a plant are much more autonomous than are those of the parts of an animal. The co-ordination between parts that does exist is achieved largely by direct chemical and physical means,⁸⁷ since plants have evolved or developed no specialized sense-organs except that of touch (sparśanendriya) and no nervous system as found in man and higher animal. They have sensitiveness generated by stimulus.⁸⁸

Actively growing plants can respond to a stimulus⁸⁹ coming from a given direction by growing more rapidly or bending away from the

77. Ibid.

78. Lokaprakāśa, 1.32, 34. p. 35¹.

79. Ibid. 1.5. 107-8 pp. 367-8.

80. Sūtrakṛtāṅga II. 3. 43. Lokaprakāśa, 1. v. 33.
Tarkarahasyadīpikā (comm. on v. 47), 159.

81. Sūtrakṛtāṅga II. 3. 43-44;

82. Lokaprakāśa, 1, 5. 32, 33, p. 353 ; 5. 107-8, p. 367-ū.

83. Bṛhatsaṁgrahāṇī, v. 200.

84. Ibid, vv. 18¹, 82.

85. Biology, p. 107, C.A. Villee.

86. Tarkarahasyadīpikā, p. 157.

87. Ibid., p. 159.

88. Ibid., p. 159.

89. Ibid., p. 189.

stimulus.⁹⁰ If an organism (e.g. creeper) is motile, it may respond to stimulus by moving toward it for support.⁹¹

The root of a plant is positively geotrophic and negatively heliotropic and the shoot is negatively geotropic but positively eliotropic.⁹²

In a few plants the responses to stimuli take place rapidly enough to be readily observed, e. g. the response of the sensitive plant "Mimosa-pudica" (Lajjāvatīlatā)⁹³

Some plants as described in Jaina Biology change the position of their leaves or flower plants in the late afternoon or evening (Sandhyā)⁹⁴ and their parts return to their original position in the morning. Several kinds of flowers close at night and open in the morning⁹⁵ with the sunrise and some soon open at night with the rise of the moon⁹⁶ and close in the day, e. g. lotuses and water lilies respectively. These changes in position have been termed sleep movements in Botany, although they are in no way related to the sleep of animals.

In the more primitive plants the basic functions⁹⁷ common to most green plants' cells may all take place in a single cell, but in the higher plants cellular specialization has occurred. The Jainācāryas have differentiated the several parts of a plant, such as, root, stem, leaf, etc.⁹⁸ and have dealt with some of the details of seed plant structure and certain functions localized in particular parts of the plant. The most obvious function of the root is to anchor⁹⁹ the plant and hold it in an upright position ; to do this, it branches and rebranches extensively through the soil.¹⁰⁰ Its second and biologically, more important function

90. Ibid., pp. 158-9 ; Lokaprakāśa 5.38.

91. Tarkarahasyadipikā, p. 159.

92. Lokaprakāśa 1. 5. 74 ; Tarkarahasyadipikā 157.

93. Tarkarahasyadipikā p. 157.

94. Ibid., p. 158.

95. Ibid. p. 158.

96. Ibid.

97. Sūtrakṛtāṅga II. 3 ; Lokaprakāśa 1, 5th Sarga ; Tarkarahasyadipikā, Ṭīkā on v. 49, pp. 157-159.

98. Sūtrakṛtāṅga II. 3. 46 ; Gommāśāra (Jivakāṇḍa). vv. 186, 189. Pāṇṇavānā, Vanaspatikāya (Jivapāṇṇavānā) 1. 40, p. 17.

99. Lokaprakāśa, 1. 5. 107.

100. Ibid.

is the absorption on water and minerals¹⁰¹ from the soil and the conduction of these substances to the stem.¹⁰²

The stem¹⁰³ consisting of trunk, branches and twigs¹⁰⁴ is the connecting link between the roots, where water and minerals enter the plant, and the leaves¹⁰⁵ which manufacture food. The vascular tissues of the stem are continuous¹⁰⁶ with those of root and leaf and provide a pathway for the exchanges of materials. The stem and its branches support the leaves so that each leaf is exposed to as much sunlight as possible. Besides, stems also support flowers and fruits¹⁰⁷ in proper position for reproduction to occur. The stem¹⁰⁸ is the source of all leaves and flowers produced by a plant, for its growing points produce primordia of leaves (kisalayas) and flowers (Puṣpa). It should be noted that root and stems are sometimes confused because many kinds of stems grow underground¹⁰⁹ and some roots¹¹⁰ grow in the air.

The leaf may be filled with kṣīra (a waxy cutin?) or may not be so (nihkṣīram) and may have fine veins (gūḍhaśīram) and their invisible joints (parvas) in between two half parts of it,¹¹¹ i.e. the upper and lower layers of the leaf epidermis filled with thin walled cells called mesophyll which are full of chloroplast. Each leaf is a specialized nutritive organ whose function is to carry on photosynthesis".¹¹²

The suction force¹¹³ connected with transpiration pull contributes to the economy of the plant by assisting the upward movement of water through the stem by concentrating in the leaves the dilute solutions

101. Bhagavati 7. 3. 275 ; Sūtrakṛtāṅga II. 3. 43 ; Lokaprakāśa, 1. 5, 107-108.

102. Ibid. (Lokaprakāśa 1. 5. 107-108)

103. Sūtrakṛtāṅga II. 3. 46, ; Lokaprakāśa 1. 5. 77 : Paññavānā 1.41, pp. 17-18 ; Gommaṭasāra (jīva) v. 189.

104. Ibid.

105. Ibid.

106. Ibid. Bhagawati, 7.3.275. Lokaprakāśa 1. 5. 107-108.

107. Ibid.

108. Sūtrakṛtāṅga II. 343 ; Bhagawati 7. 3. 275; Paññavānā, 1, 41, pp. 1. Lokaprakāśa, 1. 5. 77 ; 5. 107-108.

109. Vide Lokaprakāśa 1. 5. 88-92 ; Uttarādhyayana 36. 97, 98, 99.

110. Jīvavicāra, v. 12. Paññavānā, 1. 54. 7. 85 ; Lokaprakāśa 1. 5, 84.

111. Paññavānā 1. 54. 7. 85 ; Lokaprakāśa 1.5, 84.

112. Biology, p. 126.

113. Lokaprakāśa 1. 5. 33. 34, 5. 107-8

of minerals absorbed by the roots¹¹⁴ and need for the synthesis of new vital force by cooling the leaves.

In the synoptic survey of the plants and animals given here plants and animals may be arranged under the phyla within the kingdoms and the classes within the phyla in the order of increasing complexity as far as possible in the light of modern Biology. The numbers given are estimates of known species in the phylum.

Organism classified as plants usually have stiff cell walls and chlorophyll.

Subkingdom : Thallophyta :

Plants not forming embryos without true roots, stems or leaves ; the body is either a single cell or an aggregation of cells with little differentiation into tissues.

Phylum Cyanophyta :

The blue green algae (sevāla) with no distinct nuclei or chloroplasts, probably the most primitive of existing plants.

Phylum Chlorophyta : The green algae¹¹⁵ (sevāla), with definite nuclei and chloroplast.

Phylum Schizomycophyta : The bacteria¹¹⁶ (Plant bacteria)

Phylum Eumycophyta : The true fungi (Pañaga)¹¹⁷

Class Basidiomycetes : Mushroom (Kuhaṇa),¹¹⁸ toadstools (e. g. Sarpachatra)

Subkingdom Embryophyta : Plants forming embryo

Phylum Bryophyta : Embryophyte- plants without conducting tissues. Multicellular plants, usually terrestrial.

114. Ibid.

115. Sūtrakṛiāṅga II. 3. 35 ; Pañnavanā 1. 51, p. 21 ; Jivavicāra 8.

116. Bhagavatī 7. 3. 275, 276 ; 8. 3. 324 ; Uttarādhyayana 36-96, e.g. āluka, mūlaka, etc. contain bacteria ; Pañnavanā 1. ; 40 ff ; Gommaṭasāra (Jivakāṇḍa), v. 189, p. 117.

117. Jivavicāra 8, ; Sūtrakṛiāṅga II. 3, 55 ; Uttarādhyayana, 36. 103-104 ; Pañnavanā 1. 51, p. 21.

118. Pañnavanā 1. 52, p. 21 ; Jivābhigama p. 46 ; e. g. Sarpachatra, mushroom (toad stool)

Phylum Tracheophyta	: Vascular plants.
Sub Phylum pteropsida	: Class Gymnospermae e.g. green trees (vṛkṣas), ¹¹⁹ shrubby Plants (Gucchas) ¹²⁰ shrubs (gulmas). ¹²¹ No true flowers or evules are present, the seeds are born naked on the surface of the conescales.
Subclass Coniferophytæ	: Order Gnetales: Climbing shrubs shrubs shrubs (latā), or (Valli), ¹²² small trees in common with the angiosperms.
Class Angiospermae	: Flowering plants with seeds enclosed in an ovary (Osahi), ¹²³ e.g. rice, wheat pulses, etc.
Subclass Dicotyledoneae	: Most flowering plants. ¹²⁴ Embryos with two cotyledons or seed leaves.
Subclass Monocotyledoneae	: The grasses (trāṇa), ¹²⁵ water lilies (Nalina) ¹²⁶ orchids, etc. Leaves with parallel veins, stems in which the vascular, bundles are scattered, and flower parts in three or six. The embryo has only one seed-leaf.

It is suggestive from the study of the Jaina Āgamas that in plants, much more clearly than in animals, an evolutionary sequence is evident ranging from forms, such as, the blue greens (algae) (sevāla)¹²⁷ and plant bacteria¹²⁸ (Vanasatikāyika Jīva) which reproduce by asexual means (saṁmūrcchima) to ones with complicated life cycles and

119. Bhagavati 8. 3. 324; Paññavanā, 1. 39; Jivābhigama p. 44, etc.

120. Bhagavati 24. 4. 692.

121. Paññavanā 1, 43, p. 18.

122. Ibid, 1. 45, p. 19.

123. Ibid, 1.50, pp. 20-21.

124. Bhagavati 6. 7. 249; 2. 2. 693.

125. Paññavanā 1. 47. p. 20.

126. Bhagavati Sūtra 21. 6. 691.

127. Sevāla, Sūtrakṛtāṅga II. 3. 55; Paññavanā 1. 51, p. 2; Jivavicāra 8.

128. For plant bacteria see Bhagavati 7. 3. 276; 8. 3. 324; Uttarādhyayana 36.⁹⁶ Paññavanā 1. 40 ff.; Gommaṣāra; (Jivakaṇḍa), v. 189. p. 117. for earth quadrates see Sūtrakṛtāṅga Book 1; Bhagavati 33. 1. 884; Uttarādhyayana 36. 70; 84, 92. 108, 117; 1. 19. 55 (Ekendriyajīva Paññavanā); Gommaṣāra, (Jivakaṇḍa), v. 89, p. 68; Lokaprakāśa, 4th Sarga, v. 25; Sarga, v. 123 ff.

highly evolved adaptations until it is capable of leading an independent life. Some of the lower forms, such as fungi (pañaga)¹²⁹ which has no reproductive specialization, produce billions of spores so that by chance a few will fall in an environment favourable for generation and survival. The higher plants may produce no more than a few score seeds¹³⁰ per plant (e.g. aggabiya) but each seed has a fairly good chance of growing into a mature plant.

In the Jaina Āgamas four kinds of seeds of plants are mentioned for reproduction, (1) seeds generated at the top of the plant (aggabiya), (2) at its root (mūlabhya), (3) as its knots (porabiyā) and at its stem (Khañbhabya).¹³¹

Jaina Biology throws some light upon the germination of the seed and its embryonic development. When the seeds are ripe, they are shed from the parent plant, but a few of them do germinate shortly after being shed, most of them remain dormant during the cold or dry seasons and germinate only with the advent of the next favourable growing season.¹³²

When glanced back over many types of plant life cycles that are found from algae to angiosperms, a number of evolutionary trends appear to be evident in plant kingdom of Jaina Biology. One of these is a change from a population that is mostly haploid individuals to one that is almost entirely diploid—an evolutionary trend toward a greater size and importance of the sporophyte and a reduction in the size of the gametophyte generation.¹³³

129. Sūtrakṛtāṅga II. 3. 55 (panaga); Paññavānā 1. 51, 21; Jivavicāra, 8. (Panaga-sevalabhumiphoda ya")

130. Sūtrakṛtāṅga II. 3. 43 (aggabija)

131. Sūtrakṛtāṅga II. 43; Gommaṭasāra (Jiva) v. 186.

132. Bhagavatī 15. 1. 544

It refers to the germination of sesamum seeds with the advent of favourable growing season after the uprooting of the sesamum plant by Gośala Man-khalipūtra.

133. Sūtrakṛtāṅga II. 3. 43.

ANIMAL KINGDOM :

A classification system of animals has been formulated by the Jainā-cāryas on the basis of the observation of their structural similarities,¹ sense-organs,² mode of origin³ and development.⁴ In the study of taxonomy they have differentiated superficial and accidental similarities from the significant and fundamental ones. Homologous structures⁵ of various animals have been distinguished from analogous structures.⁶ Structure of animals may be both homologous and analogous, for example, the wings (pakṣas) of birds and bat⁷ (valgulis) have a similar structural plan and development as well as the same function.⁸ Because all animals have essentially the same problems to solve for survival, there is the basic unity of life among them.

The Basis For Animal Classification according to Jainā Biology

According to Jainā Biology, the main divisions of the animal kingdom, the phyla, are differentiated by basic characteristics which usually are not unique for a single phylum, but occur in unique combinations in various ones. Some factors basic to the determination of an animal's classification are as follows :

(a) The presence or absence of cellular differentiation⁹ and the presence of sense-organs two to five-sense-organs.¹⁰ Animals may be

1. Uttarādhyayana Sūtra 36. 179-181 ; Paññavānā 1.69. 70 ; 1. 76
Tattvārthādhigama Sūtra II. 24.
2. Bhagavati 1. 5. 48-49 ; 2.1.83-84 ; 9.32.375 ; 20.1.663 ; 24.17. 708-712.
Uttarādhyayana Sūtra 36. 127 ; 136 ; 150-155 ; Paññavānā 1.55, 57, 58, 61-91, 92-138 ; TS. II. 24
3. Bhagavati 7.5.282 ; 9.32.375 ; Uttarādhyayana 36.170 ; Jivābhigama 1.33, 57, 58, 68 ; 75 (Gabbhavukkāmīya), 84, 85, 91.]
4. Ibid.]
5. Arms of man, wings of birds, fin of fish are homologous-Tattvārtha Sūtra II. 34.
6. Wings of bat and bird are analogous structures 1. 62-63. Paññavānā, 1.62-63
7. Wings of Cammapakhi and Lomapakkhi, Paññavānā 1.86.
8. Ibid. (Wings of bats and birds have the same function)
9. Most of the two-sensed animals have one-celled body, e.g. kṛmi (worm), while the five-sensed animals have cellular differentiation.
10. Bhagavati Sūtra, 1. 5. 49 ; 2.1. 83-84 ; 9.32. 375 ; 20.1.663 ; 24.17. 108-155
Uttarādhyayana Sūtra 36. 127; 136; 150-155 Paññavānā Sutta, 1. 56. 57, 58, 61-91, 92-138 ; Tattvārthādhigama Sūtra II. 24.

either single-celled, e. g. kṛmi¹¹ (the protozoa), or composed of many kinds of cells, specialized to perform particular tasks in the body's economy, e. g. higher animals and man having five sense-organs.¹² In all the higher animals, cells are differentiated and specialized. Besides, animals may be either two-sensed¹³ or three to five-sensed.¹⁴

(b) The type of body-symmetry, whether *spherical*¹⁵ *radial*¹⁶ or *bilateral*.¹⁷ Animal bodies may be organized to one of these three types of symmetry.

(c) The number of modes of origin; generation, e. g. Saṁmūrcchima¹⁸ (generation aequivoca or asexual reproduction) and Garbhavyutkraāntika,¹⁹ (generation from the womb, sexual reproduction) – añdaja (Oviparous generation), Jarāyuja (Viviparous) and Potaja (viviparous generation without the placenta).²⁰ Some of the metazoa (higher animals) have only two embryonic cell layers or germ layers—an outer ectoderm and an entoderm, e.g. Jarāyujas and potajas.²¹

(d) The presence or absence of segmentation.²² The members of several phyla are characterized by the fact that their bodies consist of

11. Uttarādhyayana Sūtra 36. 128; Pañnavanā 1.56;] Tattvārthādhigama Sūtra II. 24. (Kṛmyādinām, etc.)
12. Pañcendriyas .. Uttarādhyayana Sūtra 36.155 ; 170, etc. Pañnavanā Sutta, 1.61, 62, 63, upto 91. 1.62 ; Tattvārthādhigamasūtra II. 24.
13. Uttarādhyayana Sūtra 36. 128 ; Pañnavanā Sutta 1.56 ; Tattvārthādhigama Sūtra II. 24.
14. Uttarādhyayana Sūtra 36. 155 ; Pañnavanā Sutta 1.61-91 ; 1.62.
15. A few of the lowest animals have this type of spherical symmetry.
16. In radial symmetry two sides are distinguishable, a top and a bottom, as in a starfish.
17. Human beings and all higher animals have bilateral symmetry, in which only one special cut will divide the body into two equal halves, e. g. the body of a man has bilateral symmetry-anterior and posterior, dorsal and ventral sides.
18. Uttarādhyayana Sūtra, 36. 170; Bhagavatī Sūtra 7. 5. 282 ; Pañnavanā 1.56, etc.
19. Uttarādhyayana Sūtra, 36. 170 ; Bhagavatī 7. 5. 282; Jivābhigama Sūtra 1. 1. 33. Pañnavanā, 1. 18, etc.
20. Tattvārthādhigama Sūtra II. 14 (Potaja) ; see also Bhagavatī, 7. 5. 282 for Añdaja and Potajā, Jivābhigama, 3. 1. 96.
21. Tattvārthādhigama Sūtra II. 34.
22. e. g. Kṛmi has no segmentation, whereas Pipilikā (ant) upto man, i.e. some higher Invertebrates and the Vertebrates have segmentation.

a row of segments,²³ each of which has the same fundamental plan, with or without variation, as the segments in front and behind. In some segmented animals, such as, man and most vertebrates the segmental character of the body is obscured.²⁴ In man the bones of the spinal column – the Vertebrae – are among the few parts of the body still clearly segmented.

(e) Unique features: There are only a few structures that belong exclusively to one phylum of the animal world. e.g. vṛścikas (scorpions)²⁵ alone have sting cells (nematocysts), although many kinds of animals have a nervous system, only the chordates to which man belongs, have a dorsally located, hollow nerve cord.²⁶

In Jaina Biology, animals are also classified according to the environment in which they live, e. g. Jalacara (aquatic), Sthalacara (terrestrial) and Nabhadara or Khecara (aerial),²⁷ but some of them are found in only one type of habitat, the members of certain phyla always live in the sea,²⁸ while the members of others are always parasitic²⁹ and so on.³⁰

A comparative study of the basis for 'Animal Classification of modern Biology may be made in the following manner :

Organisms classified as animals usually lack stiff cell walls and have no chlorophyll, mode of their nutrition is either holozoic or parasitic. Modern animal classification with illustrative examples of animals according to Jaina Biology.

Phylum protozoa : Microscopic, unicellular animals, which sometimes aggregate in animals (e. g.

23. e. g. the body of Nūpura (Neura) (earthworm, Annelid) has got several segments, each having the same fundamental plan.

24. The segmental character of the body of man is obscured by the covering of the skin.

25. Tattvārthādhigama Sūtra II. 24, Paññavānā 1.58 (vicchuta).

26. Snāyu (nhāru) see Kalyāṇakāraka, 3, 7, which mentions 9.0 nerves in human body.
(snāyu .. n.vā .. śatānī)

27. Bhagavatī Sūtra 7. 5. 282 ; Jivābhigama Sūtra 1. 3', Paññavānā Sūtra 1. 61. ff.

28. Paññavānā (Sthānapada) 1.66 ff. e.g. Saṇuddalikkha.

29. Sūtrakṛtāṅga, II. 3. 27; SBE. XLV, p. 295.
"Ihegatiyā Sattā . . . nānāvihaṇām tasathāvaraṇām poggaṇām sarīresu vā, sacittesu vā, acittesu vā, aṇusūyattee viuṭṭāmī /", Sūtrakṛtāṅga II. 3.58.

30. Uttarādhyayana Sūtra 36. 107.

Kukşikṛmi,³¹ etc.), which sometimes aggregate in colonies (e.g. sādhāraṇaśarīras). Some are free-living and others are parasitic (anusyūta)

Phylum p'atyhelminthes : The flat worm, with flat, and either oval or elongated, bilaterally symmetrical bodies (a type of kṛmi).³²

Class Castoda : The tape worms (a kind of kṛmi),³³ parasitic flat worms with no digestive tract, the body consists of a head and a chain of "segments" of individuals which bud from the head.

Phylum Nematoda : The round worms (a kind of kṛmi).³⁴ An extremely large phylum characterized by elongated. Cylindrical, bilaterally symmetrical bodies, they live as parasites in plants and animals or are free living in the soil or water.

Phylum Annelida : The segmented worms (Nūpurka).³⁵ There is a distinct head, digestive tract coelom, and some non-jointed appendages. The digestive system is divided into specialised regions.

Class Hirudinea : The leeches (Jalūkā)³⁶ flattened annelids lacking bristles and parapodia, but with suckers at anterior and posterior ends.

Phylum Arthropoda : Segmental animals with jointed appendages and hard, chitinous skin, with body divided into head, thorax and

1. Uttarādhyayana 35. 128 ; TS. II 24 ; Pañnavanā 1. 50, 56.

2. Ibid.

3. Ibid.

4. Ibid,

35. Pañnavanā 1.56. 1 ; Tattvārthādhigama Sūtra II 24.

36. It come under the category of Annelids. ; See Pañnavanā 1.56 ; TS., II. 24.

	abdomen, e. g. <i>gandupada</i>), ³⁷ (knotty-legged, Arthropoda, including crustacea, Myriapoda, etc.)
Class Crustacea	; Lobsters, crabs, etc. (a class of <i>gandupada</i>). ³⁸ Animals that are usually aquatic have two pairs of antennae, and respire by means of gills.
Class Chilopoda	; The Centipeds (<i>Śatapadika</i>). ³⁹ Each body segment except the head and tail has a pair of legs.
Class Arachnoidea	; Spiders (<i>Nandyāvarta</i>), ⁴⁰ scorpions (<i>Vṛścikas</i>). ⁴¹ Adults have no antennae. The first pair of appendages ends in pincers, the second pair is used as jaws and the last four pairs are used for walking.
Class Insecta (<i>kīṭā</i>)	: The largest group of animals, mostly terrestrial. The body is divided into a distinct head, with four pairs of appendages; the thorax has three pairs of legs and usually two pairs of wings the abdomen has no appendages. Respiration by means of tracheae. There are different orders of insects ⁴²
Order Orthoptera	: Grass-hoppers (<i>Patanga</i>) ⁴³ etc.
Order Isoptera	; Termites (<i>Kāṣṭhāhārakā</i>), ⁴⁴ etc.
Order A noplura	; Lice (<i>Kārpāsāsthika</i>), ⁴⁵ (<i>Aptera</i> , <i>Ametabola</i>)

37. Ibid.

38. Ibid.

39. Paññavanā 1.57 1. ; Uttarādhyayana Sūtra ३ 137-138. ; TS. II. 24,

40. Uttarādhyayana 36. 146-149 ; Paññavanā 1. 58.
Tattvārthādhigama Sūtra II. 34.

41. Ibid.

42. Uttarādhyayana, 36. 146-149 Paññavanā 1.58. 1.
Tattvārthādhigama Sūtra II 34,

43. Ibid.

44. Paññavanā 1. 57. 1. ; Uttarādhyayana 36. 137-138 ; TS., II. 24.

45. Ibid.

Order Coleoptera⁴⁶	; Cucumber - Weevils (Trapusamimjiya), etc. ⁴⁷
Order Lepidoptera	; Butterflies and moths (Kıta). ⁴⁸
Order Diptera	; Flies (Makşikā) mosquitos (maşaka) and gnats (Puttika). ⁴⁹
Order Hymenoptera	; Ants (pipilikā), ⁵⁰ wasps (Varaṭa) ⁵¹ bees (bhramara) ⁵² and gall flies (Damśa). ⁵³
Phylum Mollusca	; Unsegmented, soft-bodied animals, usually covered by a shell, and with a ventral muscular foot. Respiration is by means of gills, protected by a fold of the body wall, e. g. Saṅkha (conchifera, Lamelli Branchiata), Śuktika (pearl - mussels) Lamelli Branchiata). ⁵⁴
Class Gastropoda	; Snails (Śambuka), ⁵⁵ etc.
Phylum Echinoderamata⁵⁶	; Marine animals which are radially symmetrical as adults, bilaterally symmetrical as larvae.

46. Ibid.

47. Ibid.

48. Uttarādhyayana 36. 146-149; Paññavānā 1. 58. 1. Tattvārthādhigama Sūtra II. 34.

49. Ibid.

50. Paññavānā 1, 55. 1.; Uttarādhyayana 36. 137-138; TS., II. 24.

51. Uttarādhyayana 36. 146-149; Paññavānā 1. 58. 1. Tattvārthādhigama Sutrā II. 34.

52. Ibid.

53. Ibid.

54. Paññavānā 1. 56; Tattvarthādhigama Sūtra II. 24.

55. Ibid.

56. See Paññavānā for four-sensed Jalacarajivas.

Phylum Chordate⁵⁷	: Bilaterally symmetrical animals with a notochord, gill clefts in pharynx, and a dorsal, hollow neural tube.
Subphylum Vertebrata⁵⁸	: (Five-sensed Animals). Animals having a definite head, a backbone of vertebrae, a well-developed brain and usually, two pairs of limbs. They have ventrally located heart, and a pair of well developed eyes.
Class Chondrichthyes⁵⁹	: Sharks, etc., e.g. Fishes with a cartilaginous skeleton and scales of dentin and enamel imbedded in the skin.
Class Osteichthyes⁶⁰	: The bony fishes e.g. Rohitaka (Labeo - Rohita Selley fish)
Class Amphibia⁶¹	: Frog (Manduka), toads, (a kind of maṇḍuka), Salamanders, (lizard like animal), etc.

As larvae these forms breathe by gills, as adults they breathe by lungs. There are two pairs of five-toed limbs; the skin is usually scaleless.

57. The animals (man and higher animals) having five sense organs fall under the class phylum chordate which consists of the subphylum, vertebrate, animals, such as fishes (maccha), amphibia (frogs-manduka, (Bhs. 12. 8. 446), reptiles (parisarpas), birds (pakhi and mammals including man (manuss), see Uttarādhyayana 36, 155, 170, 172, 180, 18. 187, 194; Pañnavanā I. 61, 62, 63, 70, 7. 72, 73, 74, 92; Tattvārthādhigamasūtra II. 34.

58. The five-sensed animals of Jaina Biology can be classified into eight classes of the sub-phylum vertebrata of Modern Biology, viz. (1) the Agnatha the Jawless fishes, e.g. Saṁhamaccha, lamprey cells, etc. (2) the placodermi-the Jawed fishes (3) the chondrichthyes, e.g. sharks (timi ?) with cartilaginous skeletons, (4) the osteichthyes the bony fishes, e.g. 'Rohiyamaccha (Labeo-Rohita), (5) the Amphebia (frogs, Maṇḍuka) (6) the Reptilia (parisarpa)-lizards, snakes, the warm blooded fur bearing animals that suckle their youngs (Sthalacaracatuspada prāṇī, Apes and Man.

59. Sharkas (timi ?), etc.; See Pañnavanā 1.63.

60. Rohita fish found in big pond, river and sea. See Pañnav. na 1.7?.

61. Bhagavati Vyākhyāprajñapti 8. 2. 316; 12. 8. 460.

Class Reptilia

: (Parisarpa).⁶² Lizards (gṛhagolikā), snake (ahi), turtles (kūrma), crocodiles (makara), etc.

The body is covered with scales derived from the epidermis of the skin. The animals breathe by means of lungs and have a three-chambered heart.

Class Aves⁶³

: The birds (Pakṣin) : Warm blooded animals whose skin is covered with feathers (loma or pakṣa).

Class Mammalia⁶⁴

: Warm - blooded animals whose skin is covered with hair. The females have mammary glands, which secrete milk for the nourishment of the young, e. g. cow (go), buffalo (mahiṣa), goat (aja), sheep (avika), horse (aśva), ass (Khara), camel (uṣṭra), deer (mṛga), etc. up to man (manusya)

Sub Class Eutheria

: The placental mammals (Jarāyuja). The young develop within the uterus of the mother, obtaining nourishment via the placenta, e. g. Man, cow, buffalo, goat, sheep, etc.⁶⁵ Potajas also, e. g. elephant.

Order Insectivora

: Primitive Insect - eating mammals ; moles and shrews, e. g. Šavita and Lāpṛka⁶⁶ (Hedgehogs and other creatures that lap up) Insectivora.⁶⁷

Order Chiroptera

: Bats (Valguli).⁶⁸

62. Uttarādhyayana Sūtra 36. 181 ; Paññavāṇī Sutta I. 76. TS., II. 34.

63. Paññavāṇī I. 86 ; Uttarādhyayana 36. 187. Tattvarthādhigama Sūtra II. 34.

64. TS., II. 34.

65. Ibid.

66. Ibid.

67. Ibid.

68. Ibid.

Order Carnivora	: Dogs (Sunaga or Sva), Cats (Biḍālī) bears (Rkṣa), etc. ⁶⁹
Order Rodentia	: Rats (mūṣikā), squirrels (śayika), beavers and porcupines (śallaka) etc. ⁷⁰
Order Lagomorpha	: Rabbits ⁷¹ (Śaśaka) and hares (Śasā).
Order Primatee	: Monkeys, apes ⁷² and man (manuṣya). ⁷³
Order Antiodatyla	: Even-toed ungulates (dukhurā), ⁷⁴ e.g. and cattle, dear, camels etc.
Order Perissodactyla	: Odd-toed ungulates (egakhurā) horses rhinocereroses, etc. ⁷⁵
Order Preboseidea	: (Gāṇḍipadā) : Elephants (Hasti) ⁷⁶
Order Cetacea	: Whales (Timi). ⁷⁷

It is suggestive from this survey of the classification of the animal kingdom that the Jainācaryas recognized in principle the grades of likeness or similarity in animal classifications, viz. (1) the complete identity of type which exists within a single species, (2) The likeness between species of the same great genus (such species have the same great genus (such species have the same great genus) such species have the same bodily parts, differing only in degree in number, size, etc. and (3) the likeness by analogy between greatest genera themselves, on the basis of sense-organs, for they grasped firmly the homology between arm, foreleg, wings, fin, between bone and fish spine, between feather and scale.⁷⁸

They never applied any cut-and-dried method of classification of animal. They were well aware of the difficulties of the existence

69. Ibid.

70. TS. II. 34.

71. TS. II. 34.

72. Bhs. 12. 8. 450.

73. TS. II. 34 ; Uttarādhyayana Sūtra, 36. 194 ; Pañṇavānā 1. 72.

74. Pañṇavānā 1. 72.

75. Ibid., 1. 71.

76. Ibid. 1. 73.

77. Pañṇavānā 1. 63,

78. Bhagavati Vyākhyāprajñapti, 1, 5. 49; 2. 1. 83-34; 9-32-375; 20. 1. 1. 663

24. 17. 708-12; Uttarādhyayana Sūtra 36. 127; 136; 150-155.

of isolated genera and species intermediate between two such genera. But their classification is clear enough in its main lines. It was in great advance of anything that preceded it in the Vedic period and no further advance on it was made in the field of Ancient Indian Biology⁸⁰.

The widest divisions are Dvīndriya (two-sensed), Trīndriya (three-sensed), Caturīndriya, (four-sensed) and Pañcendriya (five-sensed) animals answering to the modern in vertebrates (two-sensed), three-sensed and four-sensed animals and Vertebrates (five-sensed animals) respectively on the basis of the number of sense-organs⁸¹ possessed by each of them and also on that of habitat-Jalacara (aquatic), Sthalacara (terrestrial) and Nabhadara (aerial).⁸¹ Of the pañcendriyas (five-sensed animals) the main genera are viviparous quadrupeds (cetacea) (Jarāyuja) and oviparous (aṇḍaja) birds (pakṣin), apoda-oviparous reptiles (parisarpa) and amphibia (frog-maṇḍūka) and oviparous fishes (matsya).

Besides these, there are the isolated species-man and certain intermediate species - monkey (golāṅgūla), etc. Dvīndriya, Trīndriya, and Caturīndriya prāṇis (lower and higher invertebrates) that are divided on the basis of the consistency of their inner and outer parts and sense-organs.

Each of these genera has many differentiae and they can accordingly be grouped in many ways, but the most illuminating of these as indicated by Jaina Biology is that which depends on the mode of generation - Saṁmūrcchima⁸² (asexual reproduction or spontaneous generation) and garbhavyutkrāntika⁸³ (sexual reproduction) - Aṇḍaja (oviparous), Jarāyuja and Potaja (viviparous) (placental). The highest types of animal are Jarāujas and Potajas (vivipara).⁸⁴ That is to say, those which have vital force to reproduce sexually offspring qualitatively

80. Bhagavatī Vyākhyāprajnapti 1. 5. 48; 2. 1. 83-84; 9. 32. 375; 20. 1. 663.
 24. 17. 708-12; Uttarādhyayana Sūtra 36. 127; 136; 150-155 Pañṇavānā Jivapañṇavānā 1. 56. 57, 58, 61-91, 92-138; Tattvārthādhigama [Sūtra II. 24. 34.
 81. Bhagavatī 7. 5. 282; Uttarādhyayana 36. 171; Pañṇavānā, 1. 61. p. 29.
 82. Uttarādhyayana 36. 170; Bhagavatī 7. 5. 282; Jivābhigama Sūtra 1. 33. Pañṇavānā 1. 56. etc.
 83. Uttarādhyayana 36. 170; Bhagavatī 7. 5. 282; Jivābhigama 1. 33. Pañṇavānā 1. 68, etc.
 84. Bhagavatī 7. 5. 282; Jivābhigama 3. 1. 96; Tattvārthādhigama Sūtra 11. 34.

like the parents. The next type is that in which an egg is produced.

Lower still come the types of animals which produce asexually (Saṁmūrcchima) a slimy fluid from which the younger ones develop, while in others the young simply bud off from the parents.

And finally in all lower types and occasionally even as high as in the fishes there occurs spontaneous generation (saṁmūrcchima) from lifeless matter such as sveda (dirt or sweat).⁸⁵

It is found in Jaina Biology that the organization of the body of developed animals includes the transport system of the body, i. e. blood and blood vessels⁸⁶ that supply all cells with nutrients (rasa)⁸⁷ and the waste products⁸⁸ (mutta, etc. of metabolism and the circulatory system,⁸⁹ the digestive system together with metabolism and nutrition, the excretory system, the integumentary and skeletal systems which protect and support the body, the muscular system which moves the various parts of the body one on another, the nervous system, the sense-organs by which animals obtain and process information regarding the external environment, and the endocrine system in brief.⁹⁰

Enumerating the contents of the human body the Jainācāryas state that usually this body is a collection of blood (Śoṇita)⁹¹ and blood vessels—seven hundred śirās (Veins ?), twenty four dhamaṇis (arteries ?) carrying nutrients, eight srotas (currents),⁹² lungs (phopphasaphephasa)⁹³ including eparterial bronchioles of trachea, gastro-intestinal tract starting from the mouth cavity, Oesophagus up to the column of the large intestine (Thulamīta),⁹⁴ the excretory organs—kidney (Taṇuyaṁta)⁹⁵

85. There may be germs of life in dirt or sweat according to the Biological

Science, 16, pp. 34-35.

86. Tandula Veyāliya 16, pp. 34-35 Ibid. ; Kalyāṇakāraka 3. 4.

87. Ibid., 16. p. 35

88. Ibid.

89. Ibid.

90. Tandula Veyaliya, 16. pp. 34-35 ff. ; Kalyāṇakāraka, 3.5, pp. 31 ff.

91. Tandula Veyāliya 3. p. 7; 6, p. 10 ; 16, p. 35; Kalyāṇakāraka 3. 7. p. 31 (rakta) Soniya (Angavijjā), p. 177

92. Tandula Veyāliya. 16, p. 35; Kalyāṇakāraka, 3.2, 3.3., p. 30; 3, 4. p. 31.

93. Tandula Veyāliya, 17, p. 38.

94. Tandula Veyaliya, 16, p. 35 ; Kalyāṇakāraka. 2. 4, p. 31.

and nine orifices (navasoyā),⁹⁶ skin (camma),⁹⁷ a skeleton⁹⁸ of three hundred pieces of bones,⁹⁹ articulated by one hundred sixty joints¹⁰⁰ (sandhis), with six types of joints bound together by nine hundred sinews of ligaments (ñhārus),¹⁰¹ plastered over with five hundred pieces of muscles (pēśis),¹⁰² enclosed with outer cuticle¹⁰³ (camma or ajina), with orifices (soyā),¹⁰⁴ here and there, constantly dribbling and trickling like cracked or perforated pot,¹⁰⁵ infested by helminths¹⁰⁶ and always oozing from nine orifices¹⁰⁷ (wax from the ears, rheum from the eyes, snot from the nostrils, undigested food, bile, phlegm and blood from the mouth, and from the anus and urine from the urethra through the penis¹⁰⁸ and sweating through ninety nine lakh of hair follicles¹⁰⁹ ; five sense-organs¹¹⁰ (eye, etc.), one hundred seventy sensitive parts of the body (marmas)¹¹¹ and some endocrine glands etc.¹¹²

Like Buddhaghoṣa¹¹³ the Jainācāryas give the description of the human body to create a repulsion in the minds of their monk followers towards it¹¹⁴ and suggest to them to review the different aspects of

95. Taṇuyamta ? Its function suggests that it is kidney (Tandula Veyāliyā 16, p. 35) although its literal meaning appears to be small intestine, where all eaten food is churned and digested.

96. Ibid ; Kalyāṇakāraka, 3.5, 10, 11, 12.

97. Tandula Veyāliya, p. 41.

98. Ibid..

99. Ibid., 16, p. 35 ; Kalyāṇakāraka 3. 2. p. 38.

100. Tandula Veyāliya, 16, p. 35.

101. Ibid.

102. Ibid.

103. Tandula Veyāliya, p. 41

104. Ibid, 16, p. 35, p. 41.

105. Kalyāṇakāraka 3.12, p. 32.

106. Ibid.

107. Tandula Veyāliya, 16. p. 85; p. 38; Kalyāṇakāraka, 3, 5, 10. 11, 12.

108. Ibid.

109. Tandula Veyāliya 16, p. 35.

110. Paṇṇavanā, Indriyapada, 15.

111. Tandula Veyāliya, 16, p. 35.

112. Testes, ovaries, Seminal glands, etc.

113. Visuddhimagga, VI. 89, VI. 46.

114. Tandula Veyāliya, 38r

it.¹¹⁵ They do not define like Caraka¹¹⁶ and Buddhaghoṣa¹¹⁷ that it is constructed out of five or four primary elements of matter. Nevertheless, they admit that the body is constituted of matter (Pudgala).¹¹⁸

The main aspects of the body as described by Jaina Biology are as follows: blood (śoṇita¹¹⁹ or rudhira),¹²⁰ hard or congealed fat (meda),¹²¹ semi-liquid fat (vasā),¹²² synovia (rasiyā ?)¹²³ spittle (Khela)¹²⁴ snot (śimghānaka),¹²⁵ bile (pitta),¹²⁶ phlegm (śimbhā),¹²⁷ liver (yakṛt)¹²⁸ spleen (pilihā),¹²⁹ pus (Puya or puvva),¹³⁰ heart (hiyaya),¹³¹ blood vessels (śirā-dhamanis),¹³² lymph vessels (śleṣmāśirā),¹³³ lymph (Kaph or śimbhā),¹³⁴ tissue fluid (rasa),¹³⁵ āṇapāṇa or ucchvāsa-nihsvāsat³⁶ (Oxygen and carbon-dioxide ?); lungs (Phopphasa – puphasa)¹³⁷ including eparterial bronchioles of trachea, mouth cavity (mukh),¹³⁸ stomach (udara or āmoru),¹³⁹ duodenum (pakkāśaya), small intestine (taṇuyāmīta),¹⁴⁰

115. Tandula Veyāliya, 16, p. 35; 17, p. 38, etc.

116. Caraksāṁhitā. IV. 6. 4.

117. Visudhimagga VIII, 45.

118. Tattvārthādhigamasūtra, Umāsvāti V. 9.

119. Tandula Veyāliya, 3, p. 17.

120. Ibid. 16, p. 35.

121. Ibid, p. 40.

122. Ibid.

123. Ibid.

124. Ibid.

125. Ibid.

126. Ibid. 13, p. 41.

127. Tandula Veyāliya. pp. 12, 41. ; Kalyāṇakāraka. 3. 4; p. 31,

128. Tandula Veyāliya ; Kalyāṇakāraka, p. 3. 4, p. 3.

129. Tandula Veyāliya. p. 40.

130. Tandula Veyāliya 17. 38⁴

131. Ibid.

132. Ibid., 16, p. 35; Kalyāṇakāraka 3. 4, p. 37.

133. Kalyāṇakāraka; 3. 19, p. 40.

134. Ibid 3, 7. p. 31.

135. Tandula Veyāliya. 16, p. 35.

136. Ibid, p. 8 ; Bhagavatī 1. 7. 61-2; Viśeṣāvaśyakabhbāṣya a, 2714.

137. Tandula Veyāliya, 17, p. 38.

138. Tandula Veyāliya, p. 38.

139. Tandula Veyāliya, 17, p. 38 (udara) ; Kalyāṇakāraka, 3, 4. p. 31 (āmoru).

140. Kalyāṇakāraka 3. 4.

large intestine (Thūlamīta),¹⁴¹ tongue (Jihā or jihvā),¹⁴² teethdāmīta¹⁴³ anus or rectum (pāyu),¹⁴⁴ genital (upastha),^{144/a} kidney,¹⁴⁵ nine, orifices (navasoyā),¹⁴⁶ urine (mūlta),¹⁴⁷ faeces (puriṣa),¹⁴⁸ skin (camma),¹⁴⁹ outgrowth of skin-hair (keśa),¹⁵⁰ body hairs (romas)¹⁵¹ and nails (nakha, etc.),¹⁵² sweat (seyā),¹⁵³ skeleton (aṭṭhiya),¹⁵⁴ bones (aṭṭhi),¹⁵⁵ various parts of the skeleton,¹⁵⁶ the number of bones¹⁵⁷ bone marrow (aṭṭhimimjā),¹⁵⁸ brain matter (matthulumīga),¹⁵⁹ joints (saṃdhī),¹⁶⁰ firmness of joints (saṃghayana),¹⁶¹ pieces of muscles (māṃsapeśī),¹⁶² nerves (ṇhāru),¹⁶³ ligaments (kaṃdarā),¹⁶⁴ tendons (maṃsarajju),¹⁶⁵ sense-organ (imīdiya)¹⁶⁶ and a few endocrine glandsducts

141. Tandula Veyāliya 16, p. 35.

142. Ibid. ; Kalyāṇakāraka.

143. Ibid, 3. p. 7; 16, p. 35.

144. Ibid, 16, p. 58.

144/a Ibid, p. 38.

145. Ibid. 16. p. 35.

146. Ibid.

147. Ibid.

148. Ibid.

149. Ibid. p. 41.

150. Ibid, 3, p. 7.

151. Ibid.

152. Ibid.

153. Ibid. p. 40.

154. Ibid., p. 41.

155. Ibid., 6, p. 10, 16, p. 35.

156. Ibid, 16, p. 35 ; Kalyāṇakāraka, 3.2.

157. Tandula Veyāliya, 16, p. 35 ; Kalyāṇakāraka, 3.2.

158. Tandula Veyāliya, 6, p. 10 ; Bhagavatī Sūtra, 1, 7, 61.2.

159. Ibid.

160. Tandula Veyāliya, 16, p. 35.

161. Lokaprakāśa, 3, 399. p. 132 ; Karmagrantha 1, 33-39.

162. Tandula Veyāliya, p. 6, 16, p. 35 ; Kalyāṇakāraka 3.2., p. 30.

163. Tandula Veyāliya, p. 16, p. 35 ; Kalyāṇakāraka, 3.3, p. 30.

164. Kandara means thick (or big) nerves. They may be ligaments. Also see Kalyāṇakāraka 3.4 for kaṃdarā.

165. Kalyāṇakārakā 3.4 p. 31.

166. Bhagavatī 2. 4. 99 ; Paññavānā Sutta 15, Indriyapana ; Tandula Veyāliya 3, p. 7. Tattvārtha Sūtra II Pañcendriyāṇi.

(Sukkadhbāriṇī sirā), testes,¹⁶⁷ (Vasaṇa), ovaris¹⁶⁸ (Kukṣis or garbhāśaya of the female, fallopian tubes (Sirādugam)¹⁶⁹ uterus (yoni)¹⁷⁰ etc.

It is observed in Jaina Biology that the actual process of reproduction varies tremendously from one kind of an animal to another¹⁷¹ but two basic types of reproduction, asexual or spontaneous generation (acquivoca (Saṁmūrchima) and sexual (garbhaja) or (Garbhavyutkrāntika)¹⁷² can be distinguished. Even the highest animals reproduce asexually as evidenced by the fact that "the production of identical twins from splitting of a single fertilized egg is a kind of asexual reproduction".¹⁷³

Asexual reproduction (Saṁmūrchima)¹⁷⁴ involves biologically only of single parent (i.e. it does not require parents), which splits, buds or fragments to give rise to two or more offsprings which have heredity traits identical to those of the parents.¹⁷⁵ Sexual reproduction involves two parents,¹⁷⁶ each of which contributes a specialized ovum or gamete (eggs and sperm)¹⁷⁷ which fuse to form the zygote or fertilized egg.¹⁷⁸

Human reproduction,¹⁷⁹ in common with that of most animals, is accomplished sexually by the union of specialized gametes-ova or

167. Tandula Veyāliya, 16, p. 35 ; Even Tanuyaṁta Small intestine) and Thūlaṁta (large intestine) are regarded as endocrine glands.

168. Garbhāśaya. Sthānāṅgā Tīka 6, Kucchi (?) Tandula Veyāliya 16, p. 35.

169. Tandula Veyāliya, 3, Sūtrakṛtāṅga II. 3 ; Pañnavanā 1, Jivapañnavanā ; See births of Beīḍiya to Paīcemiya Jīvas, Saṁmūrcchhima and Vyukrāntika etc. Tattvārthadhīga Sūtra II, 24 34.

170. Bhagavatī 7. 5. 282 ; Jivābhigama 3. 1. 96 ; 1. 33. 36. Pañnavanā ; Jivapañnavanā (from two-sensed to five-sensed animals).

171. Biology, p. 148, See Uttarādhyayāna Sūtra XXVI. 170. All pancendriyas are both Saṁmūrchima and Garbhaja, i. e. they have asexual and sexual reproductions.

173. Bhagavatī, 7, 5. 282 ; Jivābhigama Sūtra 3. 1. 96. ; 1. 33. 862 ; Uttarādhyayana Sūtra XXXVI. 170. Pañnavanā, Jivapañnavanā 1. 57. p. 27

174. e. g. worms (kṛmis). etc.

175. e.g. worms (kṛmis), etc.

176. See Uttarādhyayana Sūtra XXXVI. 170 ; Pañnavanā, Jivapañnavanā, Tirikkhajivapañnavanā upto Manussjivapañnavanā.

177. Sūtrakṛtāṅga II. 3.21 ; Tandula Veyāliya p. 3.

178. Ibid.

179. Tandula Veyāliya, p. 3.

eggs (ojam) produced by the male-female and sperm (sukkam) produced by the male.¹⁸⁰

A man and a woman combine in cohabitation in cunnus (Yoni) and there they deposit their humours. Therein are born the souls of different men.¹⁸¹

Then there take place the division, growth and differentiation of a fertilized egg into the remarkable complex and interdependent system of organs which is the adult animal.¹⁸² The organs are complicated and reproduced in each new individual with extreme fidelity of pattern, but many of the organs begin to function, while still developing.¹⁸³ The pattern of cleavage, blastula formation (hollow ball of cell formation or first element formation), and gastrulation is seen, with various modifications,¹⁸⁴ in all men and in the multicellular animals according to modern Biology.¹⁸⁵

Jaina Biology reveals that heredity is the tendency of individuals to resemble their progenitors.¹⁸⁶ Each new generation of organisms from two-sensed to five-sensed closely resembles its parents as is evidenced by the fact of the classification of animals on the basis of possession of the number of sensed-organs and similar structures¹⁸⁷ and certain parental characteristics¹⁸⁸ which appear frequently in successive generations of a given family tree. Although the resemblances between the parents and offsprings are close, they are usually not exact.

The expression of inherited character may be strongly influenced by the environment in which the individual develops as is found in the case of Jalacara (aquatic), Sthalacara (terrestrial) and Khecara (aerial) prāṇis (animal).¹⁸⁹

180. Ibid. ; Sthānāṅga Sutta Pañcamasthāna ; Sūtrakṛtāṅga II. 3. 56.

181. Sūtrakṛtāṅga II. 3. 56.

182. Tandula Veyāliya, 2, p 6.

183. E.g. Putrajivārasaharaṇi (embilical cord) functions to absorb food from the stream of mother's blood.

184. Tandula Veyāliya, 2. p. 6 ; Kalyāṇakaraka, 2nd chap. VV. 33, 54, 27.

185. Biology. p. 430.

186. Bhagavatī Vyākhyāprajñapti, 1. 7. 61 ; Tandula Veyāliya. 6. p. 10.

187. Pañnavanā 1, 56-91 ; Pañnavanā 1.70

188. Uttarādhyayana 36. 176 ; Pañnavanā 1. 70.

189. Pañnavanā Sutta 1. 61-91,

In regards to the determination of sex Jaina Biology explains that the relative predominance of Śukra (semen-sperm) in the fertilized ovum (gabbha) is a factor which influences the sexual character of the resulting offspring. That is, the excess of sperm cell produces the male, while that of the germ cell Oyam= Śonita) produces the female. If the sperm-cell and geru-cell i. e. Śukra and oyam śonita - are equal are neuter (napumisaka) is born.¹⁹⁰

Besides, the determination of sex depends in part on a periodicity to which the life history of the ovum in the female parent is conceived to be subject-a law under which the fertilization of the ovum on the fourth day after the menstrual discharge, or on the alternate (even) days succeeding is favourable to the foetus developing the male sexual character, and on alternate following days to the foetus assuming the female sex.¹⁹¹

The view of Jaina Biology on the determination of sex is corroborated by the evidence of Indian Āyurvedic Science and supported indirectly by modern Biology genetically in the following manner :

"In man and perhaps in other mammals maleness is determined in large part by the presence chromosome. An individual who has the constitution is nearly a normal male in his external appearance, though with under-developed gonads. An individual with one X but no Y chromosome has the appearance of an immature female".

"Eggs contain one X chromosome ; half the sperms have an X chromosome, the other half have a Y. Fertilization of an X bearing egg by an Y bearing sperm results in an XX, female, zygote. The fertilization of an X-bearing egg by a Y-bearing sperm results in an XY, male zygote."¹⁹²

Some of the phenomena in human inheritance have been observed by the Jainācāyās on the basis of some principles of inheritance of human traits as revealod in the Jaina works. It is suggested that the development of each organ of the body is regulated by a large number of genes¹⁹³ (units of inheritance). The age at which a particular gene expresses itself phenotypically may vary widely as indicated by ten daśas (stages)¹⁹⁴ of human life.

190. Tandula Veyāliya, p. 13.

191. Ibid (comm.), p. 4.

192. Biology p. 747.

193. Biology, p. 501. "Gene applies to any hereditary unit that can undergo mutation and be detected by the change it produces in the phenotype of the organism" Ibid., p. 485.

194. Tandula Veyāliyā, pp. 15-16

Most characteristics¹⁹⁵ develop long before birth but some such as hair and eye, colour, etc.¹⁹⁶ may not appear until shortly after birth. Some, such as, amaurotic idiocy (bālatva or mandatva)¹⁹⁷ becomes evident in early childhood and still others, such as, cough, phlegm, bending of the body, feeble sense-organs etc. develop only after the individual has attained maturity.

“The inheritance of mental ability or intelligence is one of the most important, yet one of the most difficult problems of human genetics”¹⁹⁹. The reference to the mental capacities of people forming a continuous series from idiot (manda or Jāda) to genius (maṇiṣi)²⁰⁰ suggests that “intelligence is inherited by a system of polygenes”²⁰¹ brought about by Karma,²⁰² other evidence²⁰³ substantiates this hypothesis.

Modern Biology explains that “The inheritance of feeble-mindedness is due to a single recessive gene”.²⁰⁴

“It is now evident that the inheritance of mental defect is much more complex. Feeble-mindedness may be caused by diseases²⁰⁵ or by other environment factors,²⁰⁶ but the majority of cases are due to inheritance”.²⁰⁷

195. Tandula Veyāliya, 1. 2, 3,

196. Ibid, 15 (Prathama dāśa)

197. Ibid. p. 15 (prathama and tṛtīya dāśa)

198. Ibid, p. 16 (hayani 6th dāśa), pavaṁca (7th dāśa)

Saṁkuiyavalicammo (8th dāśa) etc.

199. Biology, p. 504.

200. “Maṇiṣimanda”. 1st Karmagantha with Sopajñāṭikā by Devendrasūri, p. 2.

201. “The term ‘Poligenic inheritance or multiple factor inheritance is applied when two or more independent pairs of genes affect the same character in the same way and are an additive fashion”, e. g. skin colour in man, Biology p. 470.

202. “Maṇiṣijaḍayo... Karmanibandhanāṁ /” Karmagrantha 1, with Sopajñāṭikā by Devendra Sūri, p. 2.

203. Ibid (comm)

204. Biology; p. 504.

205. Ibid.

206. Viśesavaṁyakabhbhaśya p. 537.

207. Biology. p. 504.

It is suggestive from the study of Jaina Biology that the Jainācāryas have worked out a theory of a sort of gradual evolving life forms on the basis of the number of sense-organs²⁰⁸ from the micro-organisms (nigodas)²⁰⁹ – one-sensed²¹⁰ up to five-sensed animals-men²¹¹ according to their metaphysical belief that Karmaprakṛti strives to change from the simple and imperfect to the more complex and perfect as a result of modifications or progress of Karmas²¹² accumulated in successive births in past life.

But it seems unlikely that men will ever know how life originated, whether it happened only once or many times or whether it might happen again.

Like Ray and Kinnaeus²¹³ the Jainācāryas are firm believers in the unchanging nature of species as is evidenced in their classifications of organisms.²¹³

From the point of view of the present day taxonomists an evolutionary relationship among the species of organisms – plants and animals – may be discovered on the basis of their anatomy, physiology and biochemistry, their embryologic and genetic histories, etc.

A close study of the world of life of plants and animals as presented in Jaina Biology shows that there is a remarkable fitness of the organism for the place (ṭhāna),²¹⁴ in which it lives, e. g. water for aquatic animals (Jalacaras), land for terrestrial animals, (Sthalacaras) and air for aerial animals (Nabhacaras).²¹⁵ It is suggestive from this fact of fitness of organisms that their structure, of function, even of behaviour pattern, has arisen in course of evolution by natural selection

208. Uttarādhyayana Sūtra 36. 68-197.

Paññavānā Sutta 1. 19-55 ; Egimūiyajivapaññavanā upto 1. 92-138 (pañcendiya manussajivapaññavanā).

209. Bhagavatī 25. 5, 749 ; Jivābhigama Sūtra p. 997
Paññavanā 1.55 120 ; Lokaprakāśa 1. 4th Sarga v. 32,
Nigodaśatrimśikā ; Gommaṭasāra (Jiva). V. 71.

210. Uttarādhyayana Sūtra 36. 68 ff. Paññavanā 1.19-55.

211. Uttarādhyayana Sūtra, 36. 194-7; Paññavanā 1.19.55

212. Sūtrakṛtāṅga II 3. 62.

213. Biology p. 543.

214. Uttarādhyayana Sūtra 36.

215. Paññavanā Sutta 2, Ṭhāṇapayaṁ Sūtra 148-166, etc.

216. Uttarādhyayana Sūtra 6.171.

as explained by modern Biology.²¹⁷ The outcome of evolution is a population of organisms, a species, adapted to survive in certain type of "environment".²¹⁸

Although a clear cut idea of the outcome of evolution of plants and animals is not found in Jaina Biology, nevertheless, it has been noted, while studying the "characteristics of living substances" that each particular species or plant or animals has the ability to become adapted by seeking out an environment in which it is suited to make it better fitted to its present surrounding.²¹⁹

It is suggestive that in course of time organisms have become adapted and readapted²²⁰ many times as their environment changed or as they migrated to a new environment.²²¹

The analysis of the topics "The knowledge of food of organisms"²²² the types of plants and classification of animals²²³ and their habitats,²²⁴ etc., as recorded in the Jaina Āgamas, reveals that there is a tendency for each group of organisms to spread out²²⁵ and occupy as many different habitats as they can reach and which will support them,²²⁶ because of the struggle for food and living space²²⁷

The classification of animals by the Jainācāryas into Sthalacara (terrestrial), Jalacara (aqatic) and Khecara or Nabhadara (aerial) animals throws light upo their habitats and ecology to which they could grow and adapt, and make themselves better fitted in their survival.²²⁸

217. Biology p. 570; Paññavanā 1. 61-91.

218. Biology, p. 570.

219. It is indicated by the Characteristics of living substances and their cell structure and functions.

220. Sūtrakṛtāṅga II. 3; Bhaṭṭavatī 7 5 275 ; Paññavanā, Ṭhāṇapayām ; Jivābhigama. 1. 34-6 ; Tarkarahasyadīpikā, V. -9, Jainamataṁ, Tikā by Gujaratna.

221. Ibid.

222. Sūtrakṛtāṅga II. 3.

223. For types of plants. classification of Animals see Paññavanā, Jivapaññavanā ; Uttarādhyānaya Sūtra 3, etc.

224. Paññavanā Sūtra; Ṭhāṇapayam ; Sūtrakṛtāṅga II. 3

225. Trasa Jivas (motile animals always move fo food and shelter.

226. Sūtrakṛtāṅga II. 3. All motile animals do so for food and space.

227. Ibid.

228. Sūtrakṛtāṅga II. 3.

Conversely, it is observed in the Jaina Āgamas that many of the animals inhabiting the same type of habitat, e.g. water, have (developed) similar structures which make them superficially alike, even though they may be but distantly related, e. g. the dolphin and porpoises (Śuśumāra²²⁹ which are a mammals,) both bony and cartilaginous fishes, "have all evolved streamlined shapes, dorsal fins, tail fins and fliper like fore arm, hind limbs which make them look much alike".²³⁰

The evolution and adaptation of each species of organisms as suggested by biologic interrelation in Jaina Biology have not occurred in a biologic vacuum, independent of other forms, instead many species have had a marked influence on the adaptation of other species. As a result many types of cross dependency, between species have arisen. Some of the clearest and best understood of these types involves insects (Kita), e. g. Bhramara (bees), Kīṭapataṅga (butterflies and moths),²³¹ which help indirectly in the pollination of a great many plants,²³² e.g. gourd (tumbi),²³³ etc., utpala (lotus)²³⁴ etc.

A close study of the biologic interrelationship of plants and animals, their mode of nutrition, ecosystem, habitat and niche, and types of interactions,²³⁵ and principles of evolution, its living evidence, principles of ecology and the outcome evolution : adaptation as indicated in some form in Jaina Biology reveals that the communities of plants and animals are constantly undergoing an analogous reshuffling and the concept of the dynamic states of communities is a valid one. Plant and animal population are constantly subject to changes in their physical and biologic environment and must adapt or die as suggested by Āhārapada Nikṣepa (The knowledge of food) of the Sūtrakṛtāṅga²³⁶

Communities of organisms – plants and animals as described in the Jaina Āgamas exhibit growth,²³⁷ specialization and interdependence, characteristic form and even development from immaturity to maturity, old age and death,²³⁸ revealing the dynamic balance of Nature.

229. Sūtrakṛtāṅga II. 3. 57. Uttarādhyayana Sūtra 36.172; Paññavānā Sutta 1.67.

230. Biology, 583.

231. Uttarādhyayana Sūtra 36. 146, Paññavānā, Sutta 1.58.
Tattvārthādhigama Sūtra II, 24.

232. Biology, p. 586.

233. Paññavānā 1.45 (Tumbi)

234. Bhagavati 9. 33. 385; 11. (1-8)

235. Sūtrakṛtāṅga II. 3. Āhāranikṣepa

236. Sūtrakṛtāṅga II. 3.

237. Tarkarahasyadīpikā. Tīkā on v. 49 (Pratiniyatavṛddhi,)

238. Tarkarahasyadīpikā, Tīkā on v. 49, Guṇaratna, 159.

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